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Consumer Response to Selected In-Store Promotion of Cottage Cheese

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Thanks are also due to Dr. Robert Branson of the Texas Experiment station who read the manuscript and offered suggestions. The assistance and time given by the homemakers in the sample are much appreciated.

CONSUMER RESPONSE TO SELECTED IN-STORE PROMOTION OF COTTAGE CHEESE[1]

By DOROTHY DICKINS AND
ALVIRDA F. JOHNSTON

Previous studies with dairy products[2] how the need for further information n which to base promotional programs o increase the use of cottage cheese. Any dditional insight into the "hows" and whys" of the homemaker's choices hould be useful as a guide to the dairy ndustry in its efforts to stimulate fam-y interest and to consumers in provid-ng greater satisfaction per dollar spent or food.

Controlled market studies have been oncerned for the most part with increas-g sales of a particular product and with valuating merchandising. It is the pur-ose of this study to determine the na-ure and scope of the consumer respons-s resulting from selected in-store pro-otional programs with cottage cheese.

Scope and Methods

The study was made in Jackson, Mis-ssippi, a city of 147,480 according to the 960 census of population.

A representative sample of customers ten A & P and Kroger super-markets as drawn. Three of these stores were assified as having most of their cus-mers in the higher socio-economic roups, five as having most customers assified in the middle socio-economic oups, and two as having most custo-ers classified in the lower socio-onomic groups.

Ten Jitney Jungle supermarkets and e Sunflower supermarket[3] were se-ted as controls. Three of the Jitney ngle stores were classified as hav-g most of their customers in the higher cio-economic group, four as having ost customers in the middle socio-eco-oup, and three as having customers in e lower socio-economic group.

Field workers stood outside each of the experimental stores in order to ob-n the names and addresses of those entering the store, Thursday afternoon May 9, 1963, Friday May 10, 1963, and Saturday May 11, 1963. Store managers stated that less shopping was done on the first three days of the week and that customers shopping these days usually also shopped the last three days.

Each store interviewer was instructed to obtain about 60 names on Thursday afternoon and 120 each on Friday and on Saturday, or one every three to four minutes. If two or more shoppers came together, the name of only one was taken.

The shopper was asked (1) if she, or he, shopped regularly at the store; (2) if she, or he, did less than half or more than half of all grocery shopping at the store; and (3) how often she, or he, shopped at the store. If the customer said she did more than half of the grocery shopping there and shopped there at least once every two weeks, her name and address were taken. If residence was more than one mile from the store, the name was later eliminated.

Approximately 300 names and addresses were recorded at each store. Those obtained at each store (300) were divided at random into two groups, one-half for the pre-test study and one-half for the post-test study; i.e. 150 each. Each of these groups was then divided at random into three sub-groups — the sample the first substitute, the second substitute.[4]

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[1] This bulletin reports on the Mississippi subproject of the Southern Regional Project, SM-13 Revised.

[2] Dorothy Dickins, "Responses of Southern Urban Homemakers to Newer Forms of Dairy Products", Southern Cooperative Series Bulletin 82, March 1962.

[3] Data from the Sunflower store with customers from the upper socio-economic bracket were not included since the operation of a bakery in connection with the store apparently affected the average size of sales and the amount of cottage cheese per check-out.

Goals were set to complete interviews with 50 customers from each store in the pre-test study, made before the cottage cheese display in the ten experimental stores, and from the same size sample in the post-test study, made after the display. Store managers were asked about the proportion of white to Negro customers and an attempt was made to have this same proportion in the sample.

Eligibility requirements for families included in the study were: (1) Family must have 2 or more members; (2) At least one meal a day must have been served in the home to some family member during the preceding week; and (3) There must be fewer than 5 boarders.

Five hundred and eighteen schedules were completed in the pre-test study, 517 in the post-test study. Appendix A shows the number of families contacted and the schedules completed in the pre-test and post-test studies.

Sixty-seven percent of the initial sample was completed in the pre-test study compared with 59 percent in the post-test study (see Appendix A). More families were on vacation, for example, during the post-test study, therefore a slightly larger number of substitute families was used in the post-test.

The time schedule followed in this study was as follows: (1) Conducted the pre-test survey from a sample of shoppers the weeks of May 20, 27, and June 3, 1963; (2) Set up a display in each of the 10 experimental supermarkets the last 2½ days of the weeks of June 10 and June 17, 1963; (3) Conducted a post-test survey from a sample of shoppers the weeks of July 8, 15, and 22, 1963: (4) Obtained records of sales of cottage cheese per check-out count from each of 10 experimental stores and 10 control stores during the weeks of May 27, June 3, June 10, and June 17, June 24, and July 1, 1963.

The displays were up for 2½ days during two weeks in each of the 10 experimental stores (see Figure 1). Centering the display was a colorful poster emphasizing the nutritive properties of cottage cheese (low calories and high protein) and showing how it could stretch the family dollar. Beneath the poster were cartons of the various brands of cottage cheese sold in the Jackson stores.

Display and other promotional material were developed cooperatively with Texas, South Carolina, and Alabama — the other three states involved in the in-store promotion studies.

The demonstrator at the display distributed leaflets entitled, "Stretch Your Food Dollar with Cottage Cheese Dishes", which contained recipes of cottage cheese dishes that had been tested by Mississippi home economists. The leaflet was prepared at the Mississippi Agricultural Experiment Station and was edited and published by the Texas Agricultural Experiment Station which cooperated with Mississippi in the series of cottage cheese promotion studies.

Certain questions common to all cooperators in both promotional and educational phases of the regional study were included in the schedule used for interviewing families in the pre- and post-test periods. The part of the schedule dealing with cottage cheese was developed at a meeting held by Mississippi and Texas investigators. Schedule questions were designed to measure changes, if any, in consumers' knowledge and attitudes towards the use of cottage cheese as a result of the promotion. The schedules in the two periods were similar except for added questions on the "after" schedule designed to determine the use of leaflets distributed at the time the display was in the supermarket.

The Families

Differences in race, in age, and in education of male heads of households and homemakers, in household size, in source

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[4] The second substitute sample list was not used either in the pre- or post-test periods.

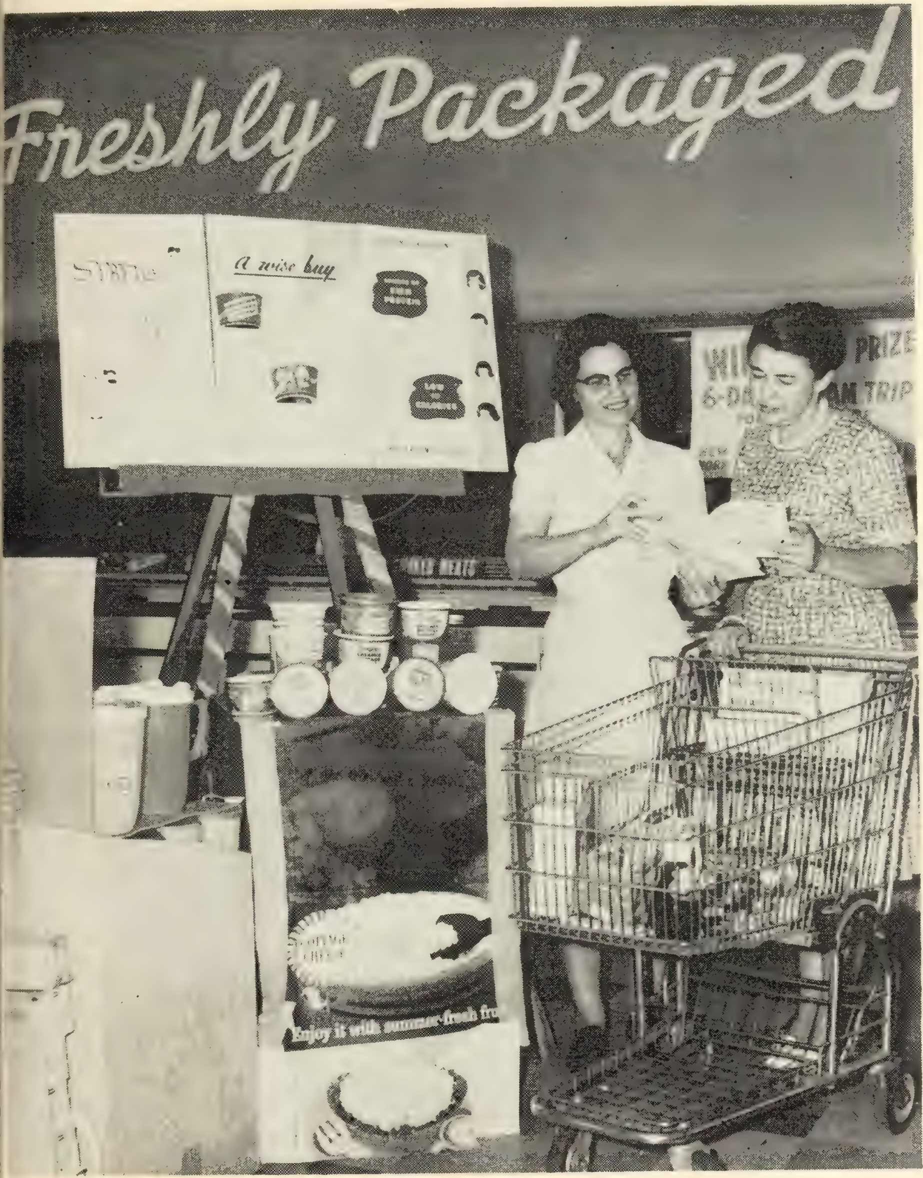
Freshly Packaged
A wise buy
PRIZE
TRIP
Enjoy it with summer-fresh fr

Figure 1. Cottage cheese display at a supermarket showing demonstrator distributing recipe pamphlets.

of income, and in per capita income of families in the pre- and post-surveys were studied by chi-square tests. Differences found were in no case significant. In other words, family characteristics in the two surveys were similar. (See Appendix B, Tables 1-8).

A little more than 90 percent of the families in each sample were white families (Appendix B, Table 1). The managers of the supermarkets included explained that most Negroes traded in neighborhood stores where they felt more at home and could get credit. Moreover, supermarkets where Negroes did more trading did not have check-out counts on their cash registers. A record of check-out count was a necessary part of this study.

A little more than one-half of the male heads of households surveyed were under 45 years of age. Nearly one-half had had training beyond high school (Appendix B, Tables 2 and 3). About two-thirds of the homemakers were less than 45 years of age. Nearly two-fifths had had training beyond high school (Appendix B, Tables 4 and 5).

More households of families in both surveys consisted of 4 members than of any other number. A little more than one-fourth of the families in both groups had 5 or more members. (See Appendix B, Table 7).

In about two-thirds of the families only the male head of the household worked for pay. In about one-fourth of the households both the male head and the homemaker worked for pay. The situation in the other families varied considerably. In some only the homemaker earned income. Others were double families with male head and parents working for pay (Appendix B, Table 6).

Family incomes in this study on a per capita basis, ranged from under $600 to over $3200 per year (Appendix B, Table 8). The modal level was $1200-1799 per person. However, slightly more than one-half had per capita incomes higher than $1800.

Homemakers

A homemaker in this study was defined as the person most familiar with food-buying habits and preferences of the household. Since they were most familiar with buying habits and preferences, a description of them is essential for interpretation of the promotion program. Three characteristics of homemakers which were given attention were: (1 Type of shoppers: (a) their shopping habits, whether impulsive, rational, or habitual; and (b) their varying attitude towards shopping. (2) Shoppers' marketing knowledge. (3) Shoppers' nutritiona knowledge.

Type of shopper. Homemakers were asked 6 questions which would give insight about them as shoppers, whether impulsive, rational, or habitual (see Appendix C-1 for method of scoring replies to the 6 questions).

On the basis of replies to these 6 questions, homemakers were scored and classified into three groups.

	Per cent
Habitual (Score 16-22)	27
Rational (Score 23-26)	46
Implusive (Score 27-33)	27

Relationships were studied to type of shopper, to race, age and education of homemaker, source of family income, per capita income, type of grocery in which traded (lower, middle, or upper socio-economic groups), and whether the family was in the pre- or post-survey (Appendix B, Table 9). A significant relationship was found between type or orientation of the homemaker and only two of these factors; i.e. source of income and type of grocery. In both cases this relationship was significant at the 1 percent level. There were more habitual shoppers among the group of women who were not gainfully employed, and more rational shoppers among those who were gainfully employed, and more rational and fewer habitual shoppers in stores of the middle socio-economic groups.

The homemaker was asked questions not only to determine the type of shopper she was, but also to find out the first, second, and third things she thought about in food shopping, how she felt about food shopping, and why.

Mentioned most often as things the homemaker thought about in food shopping were: economy, price, values — 22 percent; quality — 14 percent; menus, individual items, seasonal foods — 14 percent; family preferences — 9 percent; nutrition and diet — 8 percent; regular needs, quantity — 5 percent.

About three-fourths (72 percent) of the women said they liked shopping most or part of the time; about one-fourth (24 percent) said they disliked shopping most or part of the time. The remainder stated "don't mind" or gave no report.

The main reasons given for enjoying shopping most or part of the time were: (1) Like to see new food items and recipes in store; (2) Like to get out of house; like to see people; (3) Like to cook, like to eat; (4) It's something that has to be done.

Main reasons given for disliking shopping most or part of the time were: (1) Takes time needed for other things; (2) Budget control, have to shop for cheapest; (3) Children and other family members go along.

Marketing Knowledge. Homemakers' marketing knowledge score was based on two questions (see Appendix C-2). Marketing knowledge scores ranged from 0 through 14 with the following distribution.

	Number
Low knowledge (0-5)	299
Medium knowledge (6-10)	359
High knowledge (11-14)	377

The relationship was studied of marketing knowledge of homemaker to race, age of homemaker, education of homemaker, source of family income, per capita income, family composition, how homemaker feels about food shopping, the first thing she thinks about in food shopping, the type of grocery in which she traded (whether lower, middle, or upper socio-economic groups) and whether the family was in the pre- or the post-survey.

According to chi-square tests a significant relationship was found between marketing knowledge of the homemaker and all of these factors except two; i.e. how homemaker feels about food shopping and the first thing she thinks about in food shopping. White women, younger women, women with more schooling, women without gainful work, women from families with higher per capita income, women with children, and those shopping in stores where more customers were in the higher socio-economic groups, more often had high marketing knowledge scores.

Also, there were relatively more women in the post-survey scoring high on marketing knowledge.[5] This fact may be partly related to the season of the post-survey; i.e. in July when there was much eating out of doors and many comments in local papers about grades of foods for "outdoor cooking."

Nutritional Knowledge. Homemakers' nutritional knowledge score was based on replies about words or phrases that best explain 4 areas of nutrition; i.e. protein, carbohydrates, fats, and vitamins (see Appendix C-3 for method of scoring and Appendix D, Table 1, for a summary of replies of homemakers).

Total scores for nutritional knowledge ranged from 0 through 36 with the following distribution:

	Number
Low knowledge (22 & under)	359
Medium knowledge (23-28)	363
High knowledge (29 & over)	313

A highly significant relationship was found between nutritional knowledge of homemaker and her age, education, and working away from home. Also, such a relationship existed between her nutritional knowledge and (1) income per capita and (2) type of grocery store in which she traded. Women scoring highest in nutritional knowledge were middle-aged (35-44 years) with more schooling, not gainfully employed, of higher income per capita, and trading in groceries with more of its customers of the higher socio-economic groups.

There were fewer homemakers in the post-study scoring low nutritional knowledge than in the pre-study (see Appendix B, Table 11). The cottage cheese store displays emphasized nutritive value of cottage cheese, its good protein and low calories. However, it should be noted that in the warm weather of the post-survey local newspapers mentioned nutrition in connection with dieting quite frequently. There was no emphasis placed on cottage cheese in local newspapers.

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[5] Appendix B Table 10.

Cottage Cheese Sales

In Experimental and Control Stores

Records of sales of Cottage cheese per check-out count were obtained from each of the 10 experimental stores and the 10 control stores during the weeks of May 27, June 3, June 10, June 17, June 24, and July 1. Displays were shown in experimental stores during weeks of June 10 and June 17. There was a significant difference in sales of cottage cheese between experimental and control stores of the upper socio-economic groups, and a highly significant difference between sales of cottage cheese in experimental and control stores of the middle and lower socio-economic groups (see Appendix D, Table 2). In other words, the store-promotion program increased the sale of cottage cheese per customer count in all three types of experimental stores, especially in stores with the majority of customers from the middle and lower socio-economic levels.

Figure 2 presents a chart showing the sales of cottage cheese for experimental and control stores during the course of the test. One hundred percent represents cottage cheese sales during the week of May 27.

Ideas About Cost and Nutritive Value of Cottage Cheese

Homemakers were told: "Ann is running low on her grocery money and she needs ideas about inexpensive foods to use in main dishes. Which three of the following would you suggest she consider?" Interviewees were handed a sheet with choices mentioned. The seven main dishes named received the following per centages of the 3105 votes:

	Per cent
Hamburger	26
Chicken	21
Macaroni and cheese	15
Baked pork and beans	15
Chuck roast	10
Weiners	7
Cottage cheese in a casserole	6
or main dish salad	6

As will be noted, cottage cheese was selected by only a few homemakers as food to use in main dishes. This may in part be due to the fact that many were unfamiliar with the product as well as the cost. Differences in replies of women in the pre- and post-surveys were not statistically significant. However, the difference in replies of women from families with lower and higher per capita income was significant at the 5 percent level while the difference in replies of those shopping in the three types of groceries and those having different levels of nutritive knowledge was significant at the 1 percent level. Homemakers from families of higher income more often mentioned macaroni and cheese. Homemakers shopping in lower socio-economic stores more often mentioned weiners and baked pork and beans than those shopping in the upper socio-economic stores. Homemakers with little nutritional knowledge more often mentioned baked pork and beans and weiners than did those with highest knowledge. There was little difference in percentages of women with low and high nutritional knowledge who selected cottage cheese as the main dish.

Two questions were asked to learn what homemakers thought of the nutritive value of cottage cheese. One stated: "Sara is trying to lose weight. Which four of the following 7 foods should she consider?" In the other question the homemaker was asked to rank cottage cheese (1-9) according to protein, calcium, vitamin B^2, and iron.[6]

As will be noted, 4 oz. broiled chicken

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[6] See Appendix C-1, Question 6, for ranking type of question and method of ranking. The same procedures as used in question 6 were used in this question.

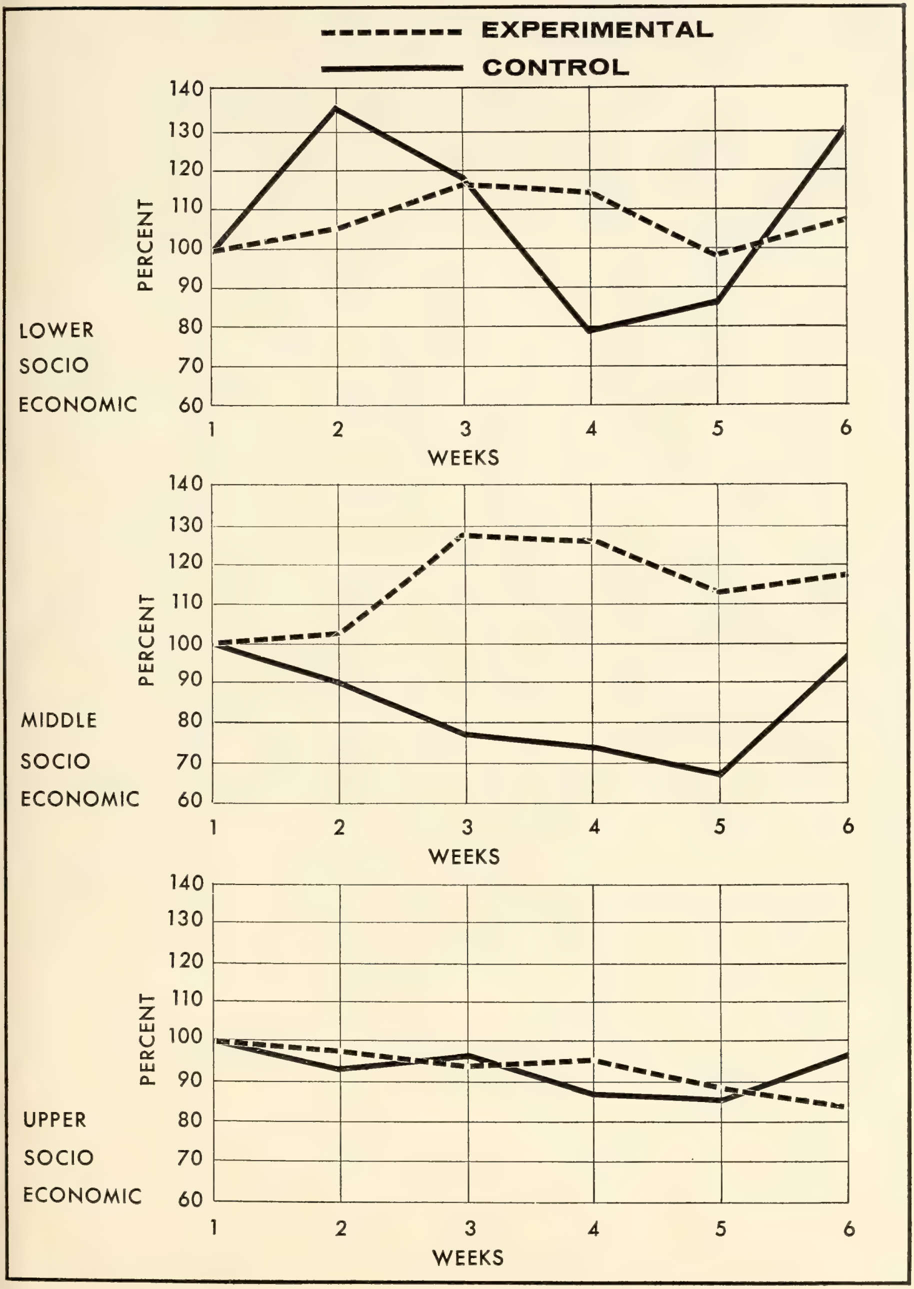

Figure 2. Comparisons of sales of cottage cheese during the 6-week period in control and experimental stores.

and ½ c. non-fat cottage cheese were selected by more women as foods Sara, who was trying to lose weight, should consider.

	Percent
4 oz. broiled chicken	23
½ c. non-fat cottage cheese	23
1 c. fruit salad	18
¼ lb. hamburger patty	18
2 deviled eggs	8
½ c. creamed cottage cheese	6
½ c. tuna fish salad	4

It is to be noted that ½ cup of cottage cheese (non-fat) contains 98 calories, and ½ cup of creamed cottage cheese only 22 calories more or 120 calories. Both deviled eggs and tuna fish salad made the usual way with mayonnaise would be higher in calories than creamed cottage cheese.

There was a highly significant difference between foods selected for Sara by women in the pre- and post-surveys (see Appendix D, Table 3). More women in the post-survey selected creamed cottage cheese. In the leaflet distributed in stores during the store display period, the fact was stressed that creamed cottage cheese is not high in calories.

Women with high nutritional knowledge more often selected hamburger and fruit salad than did those with low nutritional knowledge. Those with low nutritional knowledge more often selected deviled eggs and tuna fish salad than those with high nutritional knowledge. Women shopping in stores of the upper socio-economic group more often selected a hamburger patty than those shopping in stores of the lower socio-economic group. Women shopping in stores of the upper socio-economic group more often chose creamed cottage cheese than those shopping in stores of the lower socio-econnomic group. On the other hand, those shopping in stores of the lower socio-economic group more often mentioned non-fat cottage cheese than those shopping in stores of the upper socio-economic group.

Homemakers knew more about the protein and calcium content of cottage cheese than about the Vitamin B^2 and iron content (Table 1). The median score for protein and calcium was 8 while that of vitamin B^2 was 5 and that of iron 3. More women in the post-survey correctly placed protein, calcium, and vitamin B^2 than in the pre-survey. In all three cases there was a significant or highly significant difference (see Appendix D, Tables 4-6). However, more in the pre-survey correctly placed iron (see Appendix D, Table 7). Also, more women in the group having high nutritional knowledge correctly ranked cottage cheese as to protein and calcium content. The difference was highly significant. More women with little nutritional knowledge correctly ranked vitamin B^2 content in cottage cheese. The percentage ranking iron in cottage cheese correctly was about the same for women with low as with high nutritional knowledge.

Attitudes Towards Cottage Cheese

Interviewees were asked: "What is the first thing that comes to your mind when I say cottage cheese?" The 1035 replied as follows:

Table 1. Cottage cheese ranked according to nutrients by 1035 homemakers.*

Nutrient	No Info.	Per cent ranking cottage cheese (1-9)									Total No.
		1	2	3	4	5	6	7	8	9	
Protein	2	3	3	2	5	10	7	10	17	41	1035
Calcium	3	3	2	2	8	14	7	9	16	36	1035
Vitamin B^2	10	5	8	11	14	29	6	5	4	8	1035
Iron	7	20	14	11	9	15	6	5	5	8	1035

*1 signifies very low in the specified nutrient and 9 signifies very high in the specified nutrient.

	Per cent
Salads, fruits, vegetables	31
Diet, high protein, low in calories, husband on diet	25
Derogatory statements, such as don't like, ugh, tastes awful, looks awful	18
Other dairy products, as clabber, like buttermilk	9
Like it, delicious, appetizing	8
Nothing, no answer	4
Brand or type	3
Other foods to use cottage cheese with or on	2

Most of the comments could be classified into three categories; (1) salads, fruits, vegetables; (2) diet, high protein, low calories; and (3) derogatory statements, such as don't like.

More of those in the post-survey than in the pre-survey gave comments about liking and disliking cottage cheese which may mean that more had tasted the product during or following the display (see Appendix D, Table 8).

Difference in type of store in which respondents traded and what comes in mind when say cottage cheese was highly significant. More women trading in stores of the upper socio-economic group mentioned salads, fruits, and vegetables, and liking cottage cheese than those trading in stores of the lower socio-economic group. On the other hand, more women trading in stores of the lower socio-economic group mentioned dairy products and bad taste.

The difference was highly significant between nutritional knowledge of homemaker and what comes to her mind when you say cottage cheese. More women with little nutritional knowledge replied "dieting, low calories, bad taste" than did women with high nutritional knowledge. On the other hand, more with high nutritional knowledge than with little knowledge replied, "salads, fruits, vegetables," and "like it, delicious".

Homemakers were asked a follow-up question; i.e., "What else comes to your mind when I say cottage cheese?" The 1035 replied to this question as follows:

	Per cent
Salads, fruits, vegetables	30
Diet, high protein, low calorie, husband on diet	24
Nothing, no answer	21
Derogatory statements, don't like	9
Like it, delicious, appetizing	7
Other dairy products, as clabber, like buttermilk	4
Other foods to use cottage cheese with	4
Brand or type	1

About one-fifth, as will be noted, did not give a reply. The remainder replied similar to the way they replied to the question concerning the first thing that came to their minds.

Use of Cottage Cheese Versus Use of Other Dairy Products

Homemakers were asked what dairy products they had used during the last month. This was an open-end question; i.e., one in which the interviewee had to name those used without having a list of such products read to her. Table 2 shows percentage of homemakers from low, middle and high income families who reported use of specified products during past month. To be noted is the fact that there is greatest difference in use by low and middle income families and by middle and high income families in

Table 2. Percentage of homemakers who reported that they had used specified dairy products during the past month, classified by family income.*

	Family Income		
Dairy products	Low	Middle	High
Fluid milk	96	99	97
Yellow cheese	71	73	78
Ice cream	59	55	55
Other frozen desserts	4	3	4
Cottage cheese	28	38	50
Buttermilk	33	34	41
Canned milk	23	23	21
Butter	18	18	24
Whipping cream	13	17	20
Other kinds of cheese	7	11	17
Skim milk	5	7	10
Half and Half cream	2	6	13
Dry milk	8	7	6
Other	4	7	12

*Low income is under $1200 per capita; middle income is $1200-$2499 per capita; and high income is $2500 and over per capita.

cottage cheese than in any other dairy product.

Frequency of Serving Cottage Cheese and Kind Served

Every homemaker was asked how often she usually served cottage cheese. The frequencies reported are given by income group (Table 3).

As will be noted in the table, cottage cheese was served once a week or more in about one-fifth of the low income families. It was served this often in a little more than one-third of the high income families. In about one-fourth of the high income and nearly one-half the low income families it was never served.

Homemakers were questioned about the size of cottage cheese curd (large or small) as well as about the type of cottage cheese (creamed or non-fat) which they usually bought. Size of curd purchased was reported as follows:

	Per cent
Small curd	47
Large cur d	16
Don't know	3
Other	2
Don't serve	32

There was a significant difference (at the 5 percent level) between size of curd and use in the pre- and post-survey period. More families reported the small curd in the post-survey period.

Over 70 percent of the reasons given for choosing size of curd were related to taste and/or family preferences. The small curd in other words was selected more often because it was "better tasting" or "liked by members of my family".

The 1035 women reported that the cottage cheese they usually bought was of the following types:

	Per cent
Creamed	43
Non-fat	13
Salad type	8
Other	1
Don't know	3
Don't serve	32

Table 3. Percentage of homemakers who reported various frequencies of serving cottage cheese, classified by family income.*

	Family Income		
	Low	Middle	High
Frequency of serving			
Once a week or more often	19	23	36
Two or three times a month	10	17	18
About once a month	12	11	11
A few times a year	16	15	11
Never	43	34	24

*See footnote Table 2.

Most of the cottage cheese purchased was creamed cottage cheese. There was, moreover, a highly significant difference (at the 1 percent level) between the type of cottage cheese purchased and the time of the survey. Many more in the post-survey purchased creamed cottage cheese. Relatively fewer reported use of non-fat cottage cheese during this period.

The three reasons most often given for buying the type they did were: (1) Preferred by family members; like flavor. (2) Food value; diet food; protein. (3) Better for specific recipes, as salads; like to make salads.

Quality of Cottage Cheese

To the question, "Can you always find the quality of cottage cheese you like in your food stores", only 29 women replied "No". Twenty-three of these gave irrelevant remarks, such as "don't carry my favorite brand". The other six mentioned factors related to quality, such as "not fresh". One mentioned opening the carton and smelling it, a practice that would be frowned on by Public Health officials.

Last Time Purchased, Amount, Where, Brand, Any on Hand Now?

Replies to the question concerning the last time interviewee bought cottage cheese are shown by income class in Table 4.

Replies to the question about when homemakers last bought cottage cheese were somewhat similar to the replies concerning frequency of serving cottage cheese. More high income families had served it this week or last week than had

Table 4. Percentage of homemakers who reported various frequencies of last time bought cottage cheese, classified by family income.*

Last time bought	Family income Low	Middle	High
This week	11	17	24
Last week	20	28	33
3 - 7 weeks	12	9	11
8 weeks or more	12	9	7
Never buy; Don't remember	45	37	25

*See foot note Table 2.

low income families (57 percent as compared with 31 percent).

When asked how much they bought the last time they purchased cottage cheese, interviewees in post-survey reported more than those in the pre-survey (Table 5).

Ninety percent of those who bought cottage cheese said they had purchased the last bought at a grocery store. Nine percent said the last bought had been "delivered by dairy". One percent said they had purchased the last bought at a dairy. In other words, most cottage cheese had been purchased at a grocery store.

When questioned about the brand of cottage cheese said they had purchased it bought cottage cheese, about three-fourths of those who use it gave the name of a national brand. Eighteen percent of the families had cottage cheese on hand at the time of the visit.

Ranking of Creamed and Non-Fat Cottage Cheese According to Calories

In this study it was desired to learn whether or not the women regarded creamed cottage cheese as high in calories.[7] They were asked to rank creamed cottage cheese and non-fat cottage cheese in a nine-point scale — according to their estimate of the calories they contain, number 1 being **very** low in calories and number 9 being **very** high (see Table 6).

Table 6. Creamed cottage cheese and non-fat cottage cheese ranked according to calorie content.

Rank in calories	Creamed cottage cheese	Non-fat cottage cheese
	Per cent	Per cent
1 (very low)	6	65
2	7	19
3	10	9
4	15	3
5	17	2
6	11	*
7	10	0
8	9	1
9 (very high)	13	*
0 **	2	1

*Less than .05 per cent.
**No information.

The women in the post-survey ranked creamed cottage cheese as well as non-fat cottage cheese lower in calories than those in the pre-survey. (See Appendix D, Tables 10 and 11).

Ranking of Cottage Cheese as Cheap Source of Protein

Homemakers were asked to rank weiners, cottage cheese, and hamburger according to cheapness as a source of protein.[8] Cottage cheese was correctly ranked as the cheapest source and hamburger was next. Weiners were consider-

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[7] One-half cup of creamed cottage cheese has 120 calories; one-half cup non-fat cottage cheese has 98 calories.

[8] One pound of non-fat cottage cheese contains 88.5 grams protein; 1 lb. hamburger, 73.0 grams protein; 1 lb. creamed cottage cheese, 69.9 grams protein; and 1 lb. weiners (frankfurters), 64.5 grams protein. At the time of this study costs per pound were as follows: 32c; 45c; 32c; and 49c. More in the post-study than in the pre-study ranked cottage cheese first as to cheapness as a soure of protein. The difference between the two periods was significant at the 5 per cent level.

Table 5. Amount of cottage cheese bought by families in the pre- and post-surveys the last time cottage cheese was purchased.*

Amount bought	Pre-survey No.	Pre-survey Per cent	Post-survey No.	Post-survey Per cent	Total No.
12 ounces	283	55	261	50	544
13 - 16 ounces	30	6	34	7	64
Over 16 ounces	28	5	52	10	80
Never use or no information	177	34	170	33	347

*Chi-square equals 8.482. Significant at the 5 per cent level.

Table 7. Ranking of cottage cheese, hamburger, and weiners as to cheapness as a protein source.

	Ranked as cheapest source	Ranked as second cheapest source	Ranked as third cheapest source
	Per cent	Per cent	Per cent
Cottage cheese	47	21	32
Hamburger	28	46	26
Weiners	25	33	42
Total No.*	1021	1021	1021

*Fourteen gave no information.

Table 8. Frequency of serving dairy products in parental home.

Item	Often	Sometimes	Never	Don't Remember
	Per cent	Per cent	Per cent	Per cent
Fluid milk (sweet)	95	3	1	1
Cottage cheese	14	36	39	11
Buttermilk	63	30	6	1
Clabber	28	28	34	10
Cocoa or chocolate mlk	52	40	5	3

Table 9. Statements about cottage cheese which homemakers think are most nearly correct.

Statements	To keep good figure should not eat cottage cheese	Cottage cheese is constipating	Creamed cottage cheese supplies same nutrients as whole milk
	Per cent	Per cent	Per cent
That's completely true	4	3	45
That's partly true	9	19	39
That's completely false	65	45	4
That's partly false	19	19	5
Undecided	3	14	7
Total No.	1035	1035	1035

ed the most expensive source of protein.

As will be noted from Table 7, slightly less than half of the women ranked each of the foods correctly as to cheapness as a protein source. Forty-seven percent ranked cottage cheese as the cheapest source, 46 percent ranked hamburger as second cheapest source, and 42 percent ranked weiners as the third cheapest source.

Patterns of Serving Dairy Foods in Parental Home

When asked about the frequency that mother served 5 dairy foods (whole milk, cottage cheese, buttermilk, clabber, and cocoa or chocolate milk) when interviewee lived at home, fewer women answered "often" and more answered "never" to cottage cheese than to the other four dairy foods named (table 8).

The pattern of serving cottage cheese in the parental home was rather similar to that of serving clabber (Table 8). Also, the proportion who stated that they ate cottage cheese and clabber when served in the parental home was similar (Appendix D, Table 11). Cottage cheese is similar to clabber. In fact, it is clabber with much of the whey removed.

Replies to Statement About Value of Cottage Cheese

The three statements were: (1) If you want to keep a good figure you should not eat cottage cheese; (2) Cottage cheese is constipating; (3) Creamed cottage cheese supplies the same nutrients as whole milk.

Interviewees were asked if they thought each of the three statements was true or false. If their reply was true, then they were asked if the statement was completely or partly true. If their reply was false, then they were asked if the statement was completely or partly false. When the interviewee would not express herself she was classified as "undecided".

The majority of women knew the first two statements were false and the third statement was true (Table 9).

It was decided to test this method of getting homemaker's knowledge about cottage cheese with the method of having her rank her opinion on a 9-point scale. In this latter method she was read the statement, such as "cottage cheese is constipating" and asked to check block 1 or 2 if she thought milk was **very** constipating and block 8 or 9 if she thought it **not at all** constipating. Checking block 5 would mean she was more or less neutral; that she thought cottage cheese neither constipating or not constipating. The scale questions appeared in the first part of the schedule; the other questions (true, false, etc.) in the latter part of the schedule.

A statistical study was made comparing answers to the 3 questions by the two methods (statements versus scale). At a given level of education of homemaker there was no significant difference in the average answer in the two different ways of asking the questions. This was also the case at a given level of nutritional knowledge and in per capita income.

The scale-type question could be checked by the interviewee and did not take as much thought at the statement-type question. It was also easier to administer.

Adults and Children Disliking Cottage Cheese and Reasons

In 53 percent of the households there were no adults who disliked cottage cheese. In 22 percent of the families only one adult disliked cottage cheese; in 23 percent, two adults disliked it; and in 2 percent of the families, 3 or 4 adults disliked it. The reason most commonly given for adults disliking related to its taste which was described as "tastes bad", "not sweet enough", "just doesn't like".

Twenty-seven percent of the families had one or more children who disliked cottage cheese. The percentage of children disliking cottage cheese seemed to increase with age up to 12 years and then to decrease. This percentage was as follows:

Children	Per cent disliking
0 - 11 months	1
1 - 2 years	4
3 - 6 years	12
7 - 12 years	16
13 - 18 years	12

It may be that cottage cheese has certain appeals for the teen-ager that it does not have for the pre-adolescent. As in the case of adults, the main reason for disliking was the taste of the cottage cheese with reasons such as, "don't like it", "tastes bad," "tastes raw," "sour taste".

New Recipes Using Cottage Cheese Since Display Period

Eighty-four of the 1035 women reported they had tried new recipes using cottage cheese within the past few weeks. There was a significant difference between the percentage trying new recipes in the pre- and post-surveys. More who were interviewed in the post-survey had tried them.

Those who tried new recipes using cottage cheese were asked where they got the recipes. When a pamphlet or store promotion or display was mentioned the interviewer probed to determine whether or not it was our leaflet. The following number reported these sources: a pamphlet, 33; friends and/or relatives, 23; store promotion or display, 11; magazines, 6; newspapers, 2; and other, 9. The 84 recipes were: salads, 44; desserts, 20; main dishes, 15; spreads or dips, 3; other, 2. Ten women mentioned 2 new dishes with cottage cheese tried. These second dishes were salads by 5;

Table 10. Type of food information prefer to get from varying sources.

Type of food information	Radio	TV	Newspapers	Magazines	Newsletters	Meetings	Friends and relatives	Pamphlets	Store promotions	Other
	%	%	%	%	%	%	%	%	%	%
Food purchasing	7	23	35	5	4	2	3	3	6	1
Food preparation	1	7	3	19	3	5	19	10	3	3
Meal planning	1	4	2	8	1	3	12	10	5	14
Food purchasing & preparation	*	5	20	10	*	*	8	1	1	*
Food purchasing d meal planning	*	3	7	3	*	1	1	1	*	*
Food preparation & meal planning	0	1	1	15	*	1	9	2	*	5
All of these	*	3	11	11	*	0	7	1	1	*
Not mentioned	90	54	21	29	91	87	41	72	84	76

*Less than .05 per cent.

desserts by 4; and a main dish by one. Sources of these second recipes were: pamphlet, 4; friends or relatives, 3; store promotion, 1; magazine, 1; and other, 1.

Of the 94 new recipes tried 37 (or 39 percent) were apparently from our pamphlet. The families in the pre-survey had tried 34 new recipes; those in the post-survey, 60 new recipes.

Amount of Cottage Cheese Used Past Two Weeks

A significant difference was not found between amount of cottage cheese used in the past two weeks for the pre-survey and the post-survey. Amount purchased when last bought seems to measure better the differences in the pre- and post-study periods. This is probably related to the fact that cottage cheese is not a food used as often as once every two weeks by the majority of families.

A highly significant difference (at the 1 percent level), however, was found in the amount of cottage cheese used in the past two weeks and nutritional knowledge of homemakers. Those with homemakers of high nutritional knowledge had used larger amounts of cottage cheese than those with homemakers of low nutritional knowledge.

Type of Food Information Needed and Preferred Source

When asked if they felt a need for more information on specified items, women reported such needs as follows.*

Items	Per cent
Food value	12
Meal planning	14
Food preparation	9
Food selection	10
All of these	37
Other	1
None of these	32

*Some checked more than one.

A significant relationship was not found between any of these items checked and nutritional knowledge of homemaker.

In Table 10 is shown how women would prefer to get the various types of information. As will be noted, newspapers, magazines, friends and relatives, television, and pamphlets were the 5 sources most often mentioned. For food purchasing more preferred newspapers; for food preparation, friends and relatives; for meal planning, friends and relatives and pamphlets.

Recent Food Advertisements Stand Out

When asked to name recent food advertisements that they had heard about or seen that stood out in their minds, only 506 women could name one. Products advertised named by more women included dairy products, 17 percent; dessert (other than gelatin), 12 percent; meats, 9 percent; rice, spaghetti, cereals, 9 percent; beverages, 9 percent. Other products named varied widely from bakery products to nuts. Some named no particular product, rather a brand of a product.

The advertisement of 61 percent of these foods had been seen on television, 18 percent in magazines, 13 percent in newspapers, and 6 percent in a store display.

When asked to describe the advertisement a number mentioned 2 or 3 things, but most mentioned the product placed in a pretty setting (19 percent). Other points mentioned by from 12 to 17 percent were: Person preparing recipes; extra features added to product; children eating or admiring product; variety in product; animated picture; novel situation; picture use of new product. It would thus seem that in the advertisements remembered there were action, novelty, and/or something to see.

When asked what attracted their attention the women mentioned appearance of product (13 percent) and appeal to appetite, tasty-looking (13 percent) equally as often. Other points attracting attention mentioned by from 7 to 11 percent were: price was low; children or child in advertisement; jingle song, music; bright colors in the picture; novel idea, amusing situation; different sound effects.

Here, too, action, novelty, and/or something to see was what attracted attention.

Six Things That Influence Choice Most in Buying Food

Homemakers were given a list of 15 items to pick out the six that they thought had greatest influence in buying food. The following percentage of the 6210 items selected fell in these categories:

	Per cent
Neighbors and friends	18
Pamphlets	12
Articles about foods in newspapers	11
Food advertisements in magazines	9
Food store displays	9
Food ads on TV	8
Labels on foods on display	6
Special foods ads of a single product in newspapers	6
Food programs on TV other than ads	6
Food store ads in newspapers	5
Food ads in magazines	5
All other	11

The foregoing summary shows that neighbors and friends; pamphlets, and articles about foods in newspapers were the three items most often checked. One finds from this tabulation, however, that no one influence is overwhelmingly important; that there are many influences on choices in buying food. Advertising should not be limited to any one type.

In Appendix D, Table 12, is shown items named as first or most important of the 15 items; second in importance, third, etc. Named as most important by the largest percentage of homemakers was: food store ads in newspapers. Of second, third, and fourth importance were neighbors and friends; of fifth importance was food advertisements in magazines; and of sixth importance was recipes distributed at food stores.

Summary

This study is part of the Southern Region investigation of "Consumer Responses to Food Promotion Programs". It was the purpose of this phase of the study to determine the nature and scope of consumer responses resulting from selected in-store promotional programs with cottage cheese. Texas agricultural economists cooperated with Mississippi home economists on this phase of the study.

A representative sample of customers from ten supermarkets in Jackson, Mississippi, was drawn for the experimental study. Ten other supermarkets were selected as controls. Markets were classified according to the socio-economic level (high, middle, or low) of the majority of their customers.

Only customers who said they did more than half of their grocery shopping at selected markets, who shopped there at least once every two weeks, and who lived no farther than a mile from this market, were included in the sample.

The time schedule followed in this study was as follows: (1) Conducted pretest survey the weeks of May 20, 27, and June 3, 1963. (2) Set up a display in each of the 10 experimental supermarkets during the weeks of June 10, and June 17, 1963. (3) Conducted a post-test survey from a sample of shoppers the weeks of July 8, 15, and 22, 1963. (4) Obtained records of sales of cottage cheese per check-out count from each of 10 experimental stores and 10 control stores during the weeks of May 27, June 3, June 10, June 17, June 24, and July 1, 1963.

Centering the display was a colorful poster emphasizing the nutritive properties of cottage cheese and showing how its use could stretch the family dollar. The demonstrator at the display distributed recipe pamphlets, "Stretch Your Food Dollar with Cottage Cheese Dishes".

Family characteristis of those in the pre- and post-surveys were similar. The three characteristics of homemakers given attention in this study were (1) type of shopper, whether habitual, rational or impulsive; (2) marketing knowledge; and (3) nutritional knowledge.

According to chi-square tests the relationship between the period of the survey and the type of shopper was not significant; the relationship between the period of survey and marketing knowledge was sigificant at the one percent level; and the relationship between period of survey and nutritional knowledge was significant at the five percent level. More homemakers in the post-survey scoring high marketing and nutritional knowledge were apparently not altogether related to the store-promotion program, since Jackson newspapers carried much educational information on marketing and nutrition during July. It was not directed towards cottage cheese, however.

The store-promotion program increased the sale of cottage cheese per customer count in all three types of experimental stores, especially in stores with the majority of customers from the middle and lower socio-economic levels.

When families were classified by income there was a greater variation in the use of cottage cheese than in the use of other dairy products. Cottage cheese was never served in about one-fourth of the higher income families and in about one-half of the lower income families.

Creamed cottage cheese with small curd was the type reported used by most families. There was a highly significant difference between the type of cottage cheese purchased and the time of the survey. Many more in the post-survey purchased creamed cottage cheese.

Only 29 women replied "No" to the question, "Can you always find the quality of cottage cheese you like in your food stores?"

There was a significant difference in amount of cottage cheese purchased by those in the pre- and post-surveys. Those in the post-survey had purchased larger quantities. Ninety percent of those who bought cottage cheese had purchased it from a grocery.

In 47 percent of the households there were one or more adults who disliked cottage cheese. In 27 percent of the households one or more children disliked cottage cheese. Reasons for disliking were similar for both groups — "Tastes bad", "don't like", "sour taste".

More of those in the post-survey than in the pre-survey gave comments about liking and disliking cottage cheese which may mean that more had tasted the product during or following the display.

When asked to rank weiners, cottage cheese, and hamburger according to cheapness as a source of protein, 47 percent of the homemakers giving information ranked cottage cheese correctly as the cheapest source.

The women in the post-survey ranked both creamed cottage cheese and nonfat cottage cheese lower in calories than those in the pre-survey.

There was a highly significant difference between food selected for Sara (who was trying to lose weight) by women in the pre- and post-surveys. More women in the post-survey selected creamed cottage cheese. In the leaflet distributed in stores during the display the fact was stressed that creamed cottage cheese is not high in calories.

More women in the post-survey than in the pre-survey correctly ranked protein, calcium, and vitamin B^2.

Two methods were used to get homemakers' responses to 3 statements about cottage cheese (the true and false method and that of ranking one's opinion according to a nine-point scale). There was no significant difference in the average answer, but the scale-type question is easier to administer.

Of the 94 new recipes tried using cottage cheese 37 (or 39 percent) were apparently from the leaflet distributed at the store display. The families in the pre-survey had tried 34 new recipes; those in the post-survey, 60 new recipes.

For food purchasing more women preferred newspapers as a source of information; for food preparation they preferred friends and relatives; and for meal planning, friends and relatives and pamphlets.

In advertisements remembered there was action, novelty, and/or something to see.

When asked to check 6 items from a list of 15 items that they thought had greatest influence on their choice in buying food, the following three were most often checked; friends, pamphlets, and articles about the foods in newspapers.

Implications

It would seem that this report has some important implications for home economists and the dairy industry in their educational and dairy-products activities with families. Some implications for home economists are:

(1) Response is greater from families in which homemakers rate high in marketing and nutritional knowledge. This shows the importance of strong nutrition and consumer-education programs.

(2) Much food information is obtained from friends and relatives. Emphasis, therefore, should not only be on how to use the educational material on one's own family, but also on techniques for passing it on to friends and relatives.

(3) It would seem that many homemakers are unaware of quality factors in cottage cheese. This unawareness may be one factor in the number who reported disliking it.

(4) Lower and middle income groups need more education regarding the importance of the use and nutritive value of cottage cheese.

Some implications for the dairy industry and for processors and handlers of cottage cheese are:

(1) A good display showing the nutritive value and low cost of cottage cheese increased sales. Families bought larger quantities at a time.

(2) The pamphlet distributed at the display changed opinions, especially about calorie-content of creamed cottage cheese. Maybe the name should be changed since this name suggests high calories and creamed cottage cheese is not a high-calorie food.

(3) More than half of the new recipes using cottage cheese and reported in the post-study came from the pamphlet distributed at the display. This shows that homemakers welcome new recipes using cottage cheese.

(4) It is always to be held in mind that there are many factors that influence choices in buying food. No one of them can do all the work.

(5) Promotional efforts might well be aimed at the lower income groups. Promotion in stores in neighborhoods of low and middle class families were found to be worth while.

(6) This study shows that in effective advertising there must be action, novelty, and/or something to see.

APPENDIX A

I. Families contacted and schedules completed in the pre-test.

Families in sample	524	Families first substitute	550
Schedules completed sample	346	Schedules completed first substitute	172
Schedules not completed sample	178	Schedules not completed	19
		Names not needed	359

Reasons for 197 Not Completed

Interviewee ill or hard of hearing	8
Lived too far away (more than one mile)	20
Not eligible	35
Interviewer couldn't locate dwelling	15
Not at home after three visits	82
Other	9
Refused, would not cooperate	27
Family on two store lists	1
TOTAL	197

II. Families contacted and schedules completed in the post-test.

Families in sample	524	Families first substitute	514
Schedules completed sample	304	Schedules completed first substitute	213
Schedules not completed sample	220	Schedules not completed	20
		Names not needed	281

Reasons for 240 Not Completed

Interviewee ill, or hard of hearing	7
Lived too far away (one mile or more)	17
Not eligible	27
Interviewer couldn't locate dwelling	21
Not at home after three visits	135
Other	14
Refused, would not cooperate	16
Family on two store lists	3

APPENDIX B

Description of families in pre- and post-test studies

Table 1. Families in pre and post-studies, classified by race*

Item	White		Negro		Total No.
	No.	%	No.	%	
Pre-study	484	93.4	34	6.6	518
Post-study	471	91.1	46	8.9	517

*n. s.

Table 2. Families in the pre- and post-study classified by age of male head of household.*

Item	Under 25		25-34		35-44		45-59		60 and over		Total No. **
	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	30	5.8	113	21.8	151	29.2	144	27.8	54	10.4	492
Post-study	13	2.5	117	22.6	171	33.1	135	26.1	47	9.1	483

*n. s.
**Sixty families were not included in chi-square analysis as they gave no information or had no male head.

Table 3. Families in the pre- and post-study classified by education of male head of household.*

Item	Under 9		9-11		High School		Some college, bus. or prof.		Bachelors degree		More than bachelors		Total No. **
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	25	4.8	61	11.8	158	30.5	83	16.0	126	24.3	24	4.6	477
Post-study	22	4.3	53	10.3	147	28.4	94	18.2	120	23.2	38	7.4	474

*n. s
**Eighty-four families were not included in chi-square analysis as they gave no information or had no male head.

Table 4. Famiiles in the pre- and post-study classified by age of homemaker.*

Item	Under 25		25-34		35-44		45-59		60 and over		Total No. **
	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	51	9.8	140	27.0	155	29.9	124	23.9	46	8.9	516
Post-study	30	5.8	158	30.6	169	32.7	120	23.2	38	7.4	515

*n. s.

**Two families in each study were not included in the analysis as they gave no information or had no homemaker.

Table 5. Families in pre- and post-study classified by education of homemaker.*

Item	Under 9		9-11		High School		Some college, bus. or prof.		Bachelors or more		Total No. **
	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	22	4.3	74	14.3	214	41.3	110	21.2	82	15.8	502
Post-study	24	4.8	61	11.8	224	43.3	95	18.4	102	19.6	506

*n. s.

**Twenty-seven families were not included in analysis, as they gave no information or had no homemaker.

Table 6. Families in pre- and post-study classified by income sources.*

Item	Homemaker only		Head of household only		Both		All other		Total No.
	No.	%	No.	%	No.	%	No.	%	
Pre-study	17	3.3	371	71.6	115	22.2	15	3.0	518
Post-study	25	4.8	344	66.5	129	25.0	19	3.7	517

*n. s.

Table 7. Families in pre- and post-study classified by household size.*

Item	2 persons		3 persons		4 persons		5 persons		6 persons		7 persons		8 or more persons		Total No.
	No.		No.		No.		No.	%	No.		No.	%	No	%	
Pre-study	121	23.4	128	24.7	131	25.3	89	17.2	31	6.0	10	1.9	8	1.6	518
Post-study	113	21.9	104	20.1	143	27.7	94	18.2	41	7.9	11	2.1	11	2.2	517

*n. s.

Table 8. Familes in pre- and post-study classified by per capita income.*

Item	Under 600		600-899		900-1199		1200-1799		1800-2499		2500-3199		3200 or more		Total No. **
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	11	2.1	35	6.8	54	10.4	140	27.0	109	21.0	84	16.2	77	14.9	510
Post-study	17	3.3	26	5.0	55	10.6	139	26.9	121	23.4	67	13.0	89	17.2	514

*n. s.

**Eleven families were not included in the analysis as they gave no information concerning income.

Table 9. Families in pre- and post-study classified by type or orientation of homemaker.*

Item	Habitual		Rational		Implusive		Total No.
	No.	%	No.	%	No.	%	
Pre-study	153	29.5	228	44.0	137	26.5	518
Post-study	127	24.6	244	47.2	146	28.2	517

*n. s.

Table 10. Families in pre- and post-study classified by marketing knowledge of homemaker.*

Item	Little		Medium		Highest		Total No.
	No.	%	No.	%	No.	%	
Pre-study	179	34.6	175	33.8	164	31.7	518
Post-study	119	23.0	184	35.6	214	41.4	517

*$X^2=18.92$; significant at the 1% level.

Table 11. Families in pre- and post-study classified by nutritional knowledge of homemakers.*

Item	Little		Medium		Highest		Total No.
	No.	%	No.	%	No.	%	
Pre-study	201	38.8	167	32.2	150	29.0	518
Post-study	158	30.6	195	37.7	164	31.7	517

*$X^2=7.940$; significant at the 5% level.

APPENDIX C

Scales used for scoring homemaker: Score (1) habitual; score (2) rational; and score (3) impulsive.

Question 2*			Question 4**		
No.	Score		No.	Score	
1	3		1	3	
2	1		2	3	
3	3		3	1	
4	2		4	2	
5	1		5	2	
6	1		6	1	
7	3		7	3	
8	3		8	2	
9	2		9	2	
0	2	Total——	0	2	Total——

*The statements in questions 2 were: (1) Enjoy entertaining guests for meals; (2) Want to prepare only foods that the family likes; (3) Try new products from special store displays; (4) Encourages family members to help with meal planning; (5) Prepare a complete written shopping list for major food shopping; (6) Always serve the evening meal at the same time each day; (7) Serve meals that are original and very different from what most people have; (8) Decide on almost all food items to buy after entering store; (9) Vary meals occasionally with new products.

**The statements in question 4 were: (1) Try all kinds of food suggestions; (2) Enjoy having people drop in for meals; (3) Serve the same main dishes from week to week; (4) Buy whatever brand is on special; (5) Use food advertisements to plan food buying;

(6) Always do food shopping on the same day at same time; (7) Plan meals when I am ready to prepare them; (8) Occasionally make own recipes; (9) Do major food shopping at several stores.

Question 6	Score
(1) 1st or 2nd choice to left checked	1
3rd, 4th, or 5th space checked	2
6th or 7th space checked	3
(2) 1st or 2nd space to left checked	1
3rd, 4th, or 5th space checked	2
6th or 7th space checked	3
(3) 1st or 2nd space to left checked	1
3rd, 4th, or 5th space checked	2
6th or 7th space checked	3
(4) 1st or 2nd space to left checked	1
3rd, 4th, or 5th space checked	2
6th or 7th space checked	3
Total	

An illustration of ranking type question: Interviewee: Rank self as food buyer.

—	—	—	—	—	—	—
1	2	3	4	5	6	7

Note: If you try many brands of food each time you shop, check blank 7. If you always buy the same brands, check blank 1. If you are in between the two extremes, then check the blank that best describes your buying habits.

Question 7 (2)	Score
1 checked	1
2. Checked	2
3 checked	3
4 checked	2
None checked	2
Total	....

Question 10 (1)	Score
0 new recipes	1
1 or 2 new recipes	2
3 or more new recipes	3
Don't know, no answer	2
Total	....

Question 10 (5)	Score
0 new food items	1
1 or 2 new food items	2
3 or more new food items	3
Don't know, no answer	2
Total	....

GRAND TOTAL ....

(2) Marketing Knowledge

Question 3. USDA grading and quality	Score
Control service shield	3
Meat, poultry, eggs, canned fruit, butter or other foods named correctly	3
Other replies, such as "policeman's badge"	0

Question 11	Score
(1) How often compare package sizes and prices to see which is best buy	
Often or occasionally	2
Seldom or never	0
(2) A and B grades of eggs	2
Named A or B grade	1
Named neither A or B	0
(3) Three or more grades meat named correctly	2
1 or 2 grades correct	1
None correct	0
(4) Named grade A milk	2
Other replies	0
TOTAL	....

(3) Nutritional knowledge

Method of scoring homemakers' answers to nutrition questions.

Words or phrases	Protein	CHO	Fats	Vitamins
	No.	No.	No.	No.
General good health	2	0	0	3
Quick energy	0	3	0	0
Chicken	3	0	1	2
Growth and repair	3	0	0	3
Bacon	2	0	3	0
cottage cheese	3	0	0	2
Canteloupe	0	2	0	3
Most concentrated energy	0	0	3	0
Potatoes and candy	0	3	0	2
Pecans and other nuts	2	0	3	0
Bread	0	3	0	2
Tomatoes	0	0	0	3

APPENDIX D

Table 1. Replies of homemakers concerning word or phrase that best explains each of 4 areas of nutrition.

Words or phrases	Areas of nutrition												Total	
	Protein		CHO		Fats		Vitamins		Don't know		No information			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
General good health	469	45.3	15	1.4	4	.4	534	51.6	5	.5	8	.8	1035	100
Quick energy	309	29.8	422	40.7	99	9.6	185	17.9	12	1.2	8	.8	1035	100
Chicken	919	88.8	17	1.6	62	6.0	20	1.9	7	.7	10	1.0	1035	100
Growth & repair	465	44.9	155	15.0	19	1.8	378	36.5	9	.9	9	.9	1035	100
Bacon	268	25.8	36	3.5	711	68.7	6	.6	4	.4	10	1.0	1035	100
Cottage cheese	783	75.7	98	9.5	26	2.5	115	11.1	3	.3	10	1.0	1035	100
Cantaloupe	60	5.8	339	32.8	8	.8	594	57.3	25	2.4	9	.9	1035	100
Most concentrated energy	230	22.2	444	42.9	107	10.3	222	21.4	18	1.8	14	1.4	1035	100
Potatoes & candy	23	2.2	579	55.9	409	39.5	3	.3	8	.8	13	1.3	1035	100
Pecans & other nuts	122	11.8	102	9.9	769	74.2	26	2.6	6	.6	10	1.0	1035	100
Breads	106	10.2	505	48.8	368	35.6	35	3.4	9	.9	12	1.2	1035	100
Tomatoes	80	7.7	101	9.8	5	.5	831	80.2	7	.7	11	1.1	1035	100

Table 2. A comparison of ounces of cottage cheese sold per check-out count, by experimental and control stores.

	df	MS	F
UPPER SOCIO-ECONOMIC			
Groups	1	.374340	7.82*
Stores within groups	4	.047842	4.94*
Display periods within stores	12	.009675	4.85**
Weeks within display periods	18	.001995	
MIDDLE SOCIO-ECONOMIC			
Groups	1	.377815	13.23**
Stores within groups	7	.028566	4.89**
Display periods within stores	18	.005841	2.46*
Weeks within display periods	27	.002374	
LOWER SOCIO-ECONOMIC			
Groups	1	.347523	367.75**
Stores within groups	2	.002935	3.10 n. s.
Display periods within stores	8	.002134	2.26 n. s.
Weeks within display periods	12	.000945	

*Significant at the 5% level.

**Significant at the 1% level.

Note: On this analysis of store data on sales of cottage cheese per check-out count, analysis of variance, nested classification, was used.

Table 3. Families in the pre- and post-study classified by foods homemaker thinks one should consider in order to lose weight.*

Item	½ cup creamed Cottage cheese		¼ lb. hamburger patty		1 cup fruit salad		2 deviled eggs		½ cup tuna salad		4 oz. broiled chicken		½ cup non-fat cottage cheese		Total No.
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	83	4.0	352	17.0	408	19.7	185	8.9	100	4.8	463	22.3	481	23.2	2072
Post-study	165	8.0	396	19.1	356	17.2	132	6.4	84	4.1	482	23.3	453	21.9	2068

*X^2=44.58; significant at the 1% level.

Table 4 Families in the pre- and post-study classified by rank given by interviewees of protein in cottage cheese.

Item	1		2		3		4		5		6		7		8		9		Total**
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	18	3.5	18	3.5	19	3.7	39	7.5	52	10.0	46	8.9	56	10.8	69	13.3	188	36.3	505
Post-study	12	2.3	11	2.1	5	1.0	10	1.9	54	10.4	28	5.4	50	9.7	107	20.7	236	45.6	513

*X^2=46.55; significant at the 1% level.

**Seventeen families were not included in the chi-square analysis as they gave no information.

Table 5. Families in the pre- and post-study classified by rank given by interviewee of calcium in cottage cheese.*

Item	1		2		3		4		5		6		7		8		9		Total**
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	16	3.1	12	2.3	21	4.1	45	8.7	91	17.6	38	7.3	55	10.6	74	14.3	146	28.2	498
Post-study	13	2.5	7	1.4	6	1.2	38	7.4	54	10.4	32	6.2	44	8.5	88	17.0	226	43.7	508

*X^2=40.05; significant at the 1% level.

**Twenty-nine families were not included in chi-square analysis as they gave no information.

Table 6. Families in the pre- and post-study classified by rank given by interviewee of vitamin B^2 in cottage cheese.*

Item	1		2		3		4		5		6		7		8		9		Total**
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	31	6.0	45	8.7	67	12.9	67	12.9	156	30.1	26	5.0	27	5.2	24	4.6	28	5.4	471
Post-study	24	4.6	37	7.2	45	8.7	79	15.3	139	26.9	37	7.2	29	5.6	17	3.3	55	10.6	462

*$X^2=19.84$; significant at the 1% level.

**One hundred and two families were not included in the chi-square analysis as they gave no information.

Table 7. Families in the pre- and post-study classified by rank given by interviewee of iron in cottage cheese*.

Item	1		2		3		4		5		6		7		8		9		Total**
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	115	22.2	105	20.3	64	12.4	32	6.2	72	13.9	20	3.9	25	4.8	24	4.6	26	5.0	483
Post-study	88	17.0	42	8.1	52	10.1	57	11.0	81	15.7	42	8.1	31	6.0	27	5.2	56	10.8	476

*$X^2=58.94$; significant at the 1% level.

**Seventy-six families were not included in the chi-square analysis as they gave no information.

Table 8. Families in the pre- and post-study classified by first thing that comes to interviewee's mind when mention cottage cheese.*

Item	Nothing, no answer		Brand or type		Salads, fruits, vegetables		Like it; appetizing		Diet; non-fattening; high protein		Other dairy products		Bad taste; & other derogatory remarks		Other foods to use cottage cheese with		Total**
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Pre-study	24	4.6	16	3.1	166	32.0	31	6.0	135	26.1	48	9.3	80	15.4	16	3.1	516
Post-study	13	2.5	13	2.5	155	30.0	47	9.1	120	23.2	48	9.3	110	21.3	8	1.5	515

*$X^2=15.52$; significant at the 5% level.

**Five families naming "other" things were not included in the analysis.

Table 9. Creamed cottage cheese ranked according to calorie content, by homemakers in the pre- and post-survey.*

Rank	Pre-survey		Post-survey		Total No.
	No.	%	No.	%	
1 (very low)	25	4.9	39	7.6	64
2	31	6.1	43	8.4	74
3	44	8.7	60	11.7	104
4	59	11.7	96	18.7	155
5	93	18.4	86	16.7	179
6	65	12.8	46	8.9	111
7	56	11.1	45	8.8	101
8	51	10.1	46	8.9	97
9 (very high)	82	16.2	53	10.3	135
TOTAL	506	100.0	514	100.0	1020

*$X^2=27.45$; significant at the 1% level.

**Fifteen gave no information and were not included in the chi-square analysis.

Table 10. Non-fat cottage cheese ranked according to calorie content by homemakers in the pre- and post-survey.*

Rank	Pre-survey		Post-survey		Total No.**
	No.	%	No.	%	
1 (very low)	295	58.6	378	73.7	673
2	110	21.9	90	17.5	200
3	61	12.1	35	6.8	96
4	21	4.2	8	1.6	29
5	16	3.2	2	.4	18
TOTAL	503	100.0	513	100.0	1016

*$X^2=35.90$; highly significant.

**Thirteen gave no information and six women ranked this cheese 6 - 9; these nineteen cases were not included in the analysis.

Table 11. Specified dairy products drunk or eaten when in parental home.

Item	Yes	No	Can't remember	Total No.
	%	%	%	
Fluid milk (sweet)	88.8	10.7	.5	1035
Cottage cheese	27.8	61.4	10.7	1035
Buttermilk	61.0	37.7	1.4	1035
Clabber	28.2	62.7	9.1	1035
Cocoa or chocolate milk	73.8	23.2	3.0	1035

Table 12. Sources of greatest influence in food buying, checked by homemakers.

Greatest influence	Most important	2nd most important	3rd most important	4th most important	5th most important	6th most important
	%	%	%	%	%	%
Articles in newspapers	22.3	12.8	8.4	7.6	7.4	8.4
Special food ads of a single food in newspaper	4.8	8.7	7.4	4.6	5.9	6.0
Radio programs other than ads	1.7	1.4	1.9	1.5	2.7	3.7
Food ads on radio	1.4	1.8	1.6	1.5	2.0	1.6
Food programs on TV other than ads	3.3	5.2	7.9	7.4	6.0	6.9
Food ads on TV	5.0	6.9	9.8	7.9	8.4	7.4
Food store displays	4.2	9.1	10.6	10.7	10.0	6.2
Labels on foods on display	4.1	7.0	5.9	8.0	7.0	6.3
Neighbors and friends	8.3	16.8	16.2	14.6	10.1	7.2
Food ads in magazines	4.1	8.9	9.5	11.3	10.9	10.2
Tasting samples at the grocery store	2.4	2.2	3.2	5.5	5.6	8.4
Pamphlets	.4	1.7	1.8	3.7	4.3	6.2
Food store ads in newspapers	33.5	11.2	8.9	6.7	5.7	5.1
Recipes distributed at food store or elsewhere	1.4	3.5	3.7	5.0	8.3	10.3
Other	1.3	.8	.3	0	.7	.7
No information	1.9	2.1	2.8	3.8	5.0	5.3

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The Use of the Mist Blower for Control of Undersirable Hardwoods

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On Cover:

Figure 1. Mist blower with three hole outlet spraying to the rear of the tractor.

THE USE OF THE MIST BLOWER FOR CONTROL OF UNDESIRABLE HARDWOODS

By JOHN W. STARR

The invasion of pine sites by undesirable hardwood species has become a maor problem in forest land management n the South. Since in much of the southern pine region, nature favors forests in which certain hardwood species predomnate, some means of interrupting this natural climax trend will have to be found if we desire to grow pure stands of pine.

The application of chemicals for control of these hardwood species offers a soluion to this problem. If the size of the stems to be removed is large enough and the number per acre is small enough he tree injector can and is doing a satisfactory job. However, the most difficult portion of a hardwood control program is he understory of undesirable species hat often develops under pine stands. This understory may reach the height of 20 to 30 feet and number as many as 5,000 to 10,000 stems per acre. The number of stems to be treated per acre would probably make the use of a tree injector mpractical.

This condition brought about the development of tractor mounted mist blowers. The primary objective of mist blowing is he removal of these dense stands of mall hardwoods which often exist as understories in coniferous forest.

The mist blower was first introduced o southern forestry in 1957 by Mr. S. F. Potts of Crawford, Mississippi, a retired ntomologist with the U. S. Department f Agriculture. Mr. Potts, who has had ome 30 years of research in pesticide application equipment, felt that herbicides ould be applied to foliage at low volumes and high concentrations with satsfactory results. The idea of foliage application, of course, was not new to forst management. However, the use of oliage spray was usually thought of as high volume application (40 to 50 gallons per acre) with low concentration. With the mist blower we are thinking in terms of low volume application (3 to 5 gallons per acre) with high concentration.

The role of the mist blower in a herbicide program will vary from operation to operation. The idea that the new technique would cure all of our hardwood control problems on pine sites is not true. Basically the technique can be and has been used to accomplish two objectives: First, to release already established pines, either natural or planted, that are being overtopped by less desirable hardwood species, and second, to prepare sites for planting that have a heavy cover of undesirable hardwoods, or in other words complete stand conversion.

The two objectives are entirely different and will require different treatments. In the first, release, we need a very selective chemical and the effect of herbicide need not be for a long period of time. In the second, where the mist blower is used as a site preparation measure for stand conversion, we do not need a selective chemical and the control will have to last for several years until the planted pines are established and on top of the resurging hardwoods.

Another, and more limited, use of the mist blower is the control of an undesirable understory of hardwoods with an overstory of pine or a mixture of pine and hardwood. The removal of this understory of hardwoods, even when reproduction is not needed, has been shown to increase the growth rate of the pine overstory during dry seasons.

Many methods of undesirable hardwood control have been used and tested on upland sites. Some of these are; all of the individual stem treatment methods, high volume foliage spray, aerial application, controlled burning, and mist blowing. All have proven effective in some cases but no one method will fit all conditions. We have to choose the best method to accomplish the end objective. The purpose of this article is not to recommend the mist blower for all undesirable hardwood control but to point out some of the advantages and disadvantages of this technique.

In mist blowing, as with most methods of hardwood control, there are many considerations that have to be made before the technique should be put into operation. The overall objective should be considered to be sure that the technique or method will accomplish this objective. If mist blowing is chosen, then serious consideration will have to be given several important points.

Time of Application

The time of year that the treatment is to be applied deserves much consideration. For any foliage spray method, of course, we have to wait until the trees are in leaf. It would be highly desirable if we could make a dormant season application accomplish the objective. The understory would be less dense, the operator could better see what he is doing, and we could expect better coverage. This has been tried but in the South it has not been effective at the rates used. But even during the growing season the effectiveness of the treatment may differ due to the soil moisture conditions at the time of spray. From research plots at Mississippi State University it appears that soil moisture at the time of spraying is more important to hardwood kill than the point in time during the growing season when spraying is accomplished.

Equipment

The machine to use must be given careful consideration. It must be a rugged piece of equipment, capable of taking a terrific beating from brush. It should have a minimum capacity of 30 to 40 gallons of solution. It must be capable of calibration and be able to hold this calibration for considerable lengths of time This calibration has to be done in relation to brush density, tractor speed, an the volume to be applied per acre. Fo most forestry operations a machine in th 5 to 14 horsepower class would be bes suited. If we use a much larger machine it is too heavy and cumbersome to accomplish the job.

Tractors in the John Deere 440 clas have been used in the past to carry th blower. However, since the blowers ar calibrated on tractor speed if the ter rain is rough or the brush being treate is very dense it would be desirable to us a heavier tractor, maybe in the cat D-class.

Weather Conditions

Weather condition under which mis blowing is done may affect the outcome Since the chemicals that have been use for mist blowing will cause considerabl damage to crops, it is necessary that a precaution be taken to prevent drif Wind velocity is critical in mist blowing No spraying should be done if the win velocity is 10 miles per hour or more. calm still day of high humidity is idea Rain following mist blowing is not cri ical if it does not occur almost immed iately after spraying.

Effective Swath Width

Swath width and type of outlet wi have to be decided upon. For most fo estry work the three-hole outlet pointe to the rear of the tractor seems to give th best results. The single-hole outlet ca be used in places where one pass wi give complete coverage. An example o this would be ditch bank or roadsic spraying. With the three-hole outlet swath 30 to 35 feet wide can be main tained. This, of course, will have to b adjusted depending on the density of th brush. Since incomplete coverage probably one of the primary reasons fo

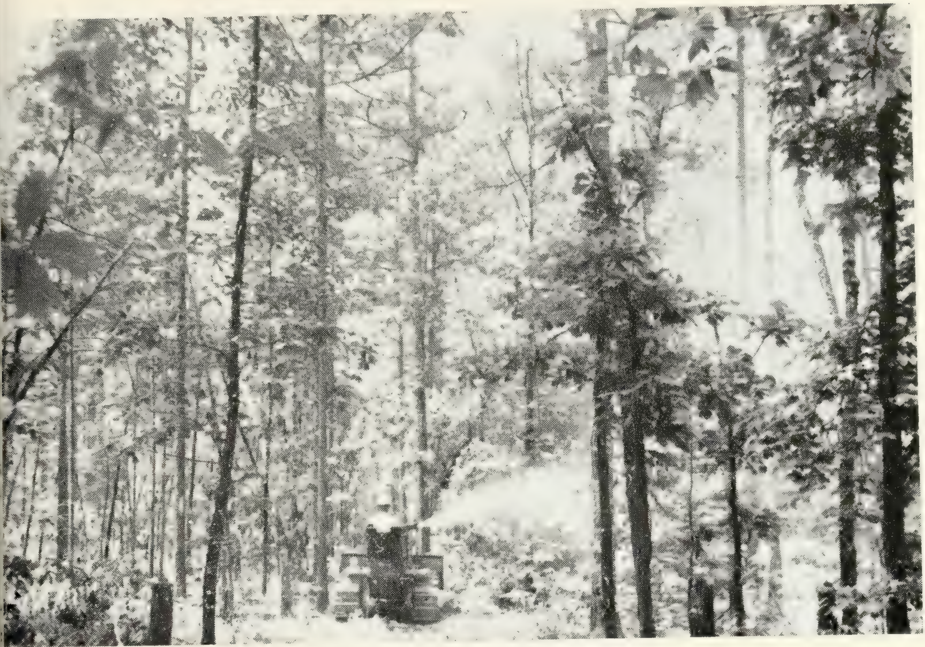

Figure 2. Mist blower with single hole outlet spraying at right angle to path of tractor.

poor results in using the mist blower, too much emphasis cannot be put on this point. In some cases it may be necessary to use flagmen in order to obtain good coverage. The use of sensitized cards to determine the pattern and completeness of the coverage is a useful means of insuring coverage.

Stand and Site Conditions

In order to insure good, or acceptable, results from mist blowing the objective of the operation must be firmly in mind and the species composition along with the site condition must be studied. If the release of already established pines is the objective the species composition is not as critical as where a site is being prepared for planting. Even where release is the primary objective if there is an abundance of hard to kill species such as red maple, water oak, willow oak, elm, and hickory, good results cannot be expected. However if the brush being treated is made up mainly of species such as sweetgum, post oak, and red oak, good results can be expected. The point is that if the site is being prepared for planting it will require longer control than if the objective is release. Also that the species composition will to a large degree control the effectiveness of the treatment.

The 1959 Study

In addition to these considerations already discussed there are the questions of: What chemical to use? What carrier to use? What rate to apply per acre? And at what volume of total solution per acre to apply this rate? In an attempt to answer some of these questions the Forestry Department of the Mississippi Agricultural Experiment Station in 1959 began a series of tests on the use of the mist blower for control of undesirable hardwoods.

The chemicals used in the first test, the 1959 study, were the amine, ester, emulsifiable acid, and invert emulsion formulations of 2,4,5-Trichlorophenoxy-acetic acid. These individual chemicals are

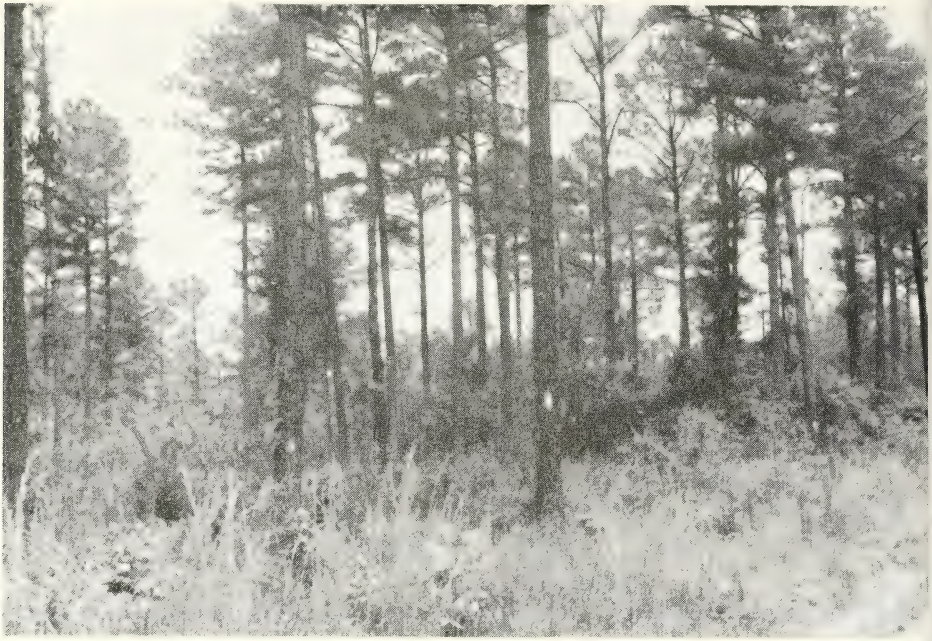

Figure 3. Pine overstory with hardwood understory. This understory could be removed by mist blowing but fire would probably be cheaper.

described in the footnotes of the tables.

The rates of application were two and four pounds of acid equivalent per acre. These were applied at three gallons and five gallons of total solution per acre.

The evaluation of the plots was set up to answer two questions: What was the overall effect of the treatment on reduction or increase of pine and hardwood stems per acre? (Table 1) What was the percent kill of red oak, post oak, sweetgum, and hickory by treatments? (Table 2)

Conclusions: From this test some cosclusions have been drawn:

1. There was no significant difference between the two-pound treatments and the four-pound treatments, both at five gallons of total solution per acre.

2. Overall there was no significant difference between the three-gallon and the five-gallon treatments; however, by individual chemicals both the non-emulsifiable ester and the emulsifiable acid were better at the five-gallon rate.

3. At four pounds in five gallons the emulsifiable acid was better than the rest of the chemicals and the amine was poorer.

4. At two pounds in five gallons the non-emulsifiable ester was better while the amine was again poorer.

5. At two pounds in three gallons the emulsifiable acid and the amine were poorer than the rest of the chemicals.

6. As for the overall effect, there was a significant increase in the number of pines per acre by the fourth evaluation on all plots.

7. The total number of hardwoods stems per acre was reduced initially, however, by the fourth evaluation this reduction was not as great. The size of the hardwoods was reduced and an adequate number of pines were free to grow.

Results: From these data it appears that already established pines can be released from hardwood brush made up of southern red oak, post oak, sweetgum,

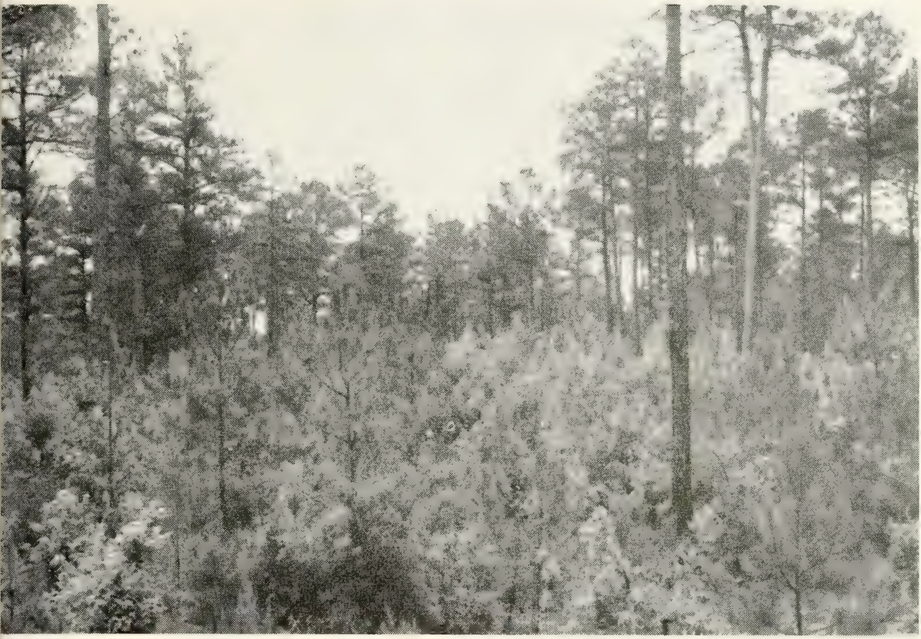

Figure 4. Area where a mist blower may be used for release of already established pines. The pines and hardwoods are almost equal in height with a good possibility of the hardwoods overtopping the pines.

and hickory on average pine sites. If the area is to be planted it appears that the planting will have to be done soon after mistblowing or the resurging hardwoods will overtop the pine seedlings.

The 1960 Study

Another test, the 1960 study, was set up to determine if we could go below the two pounds acid equivalent per acre rate and to study the effect of brush density on the overall effectiveness of the treatments. Only one chemical was used in this test, the non-emulsifiable ester formulation of 2,4,5-T containing four pounds of acid equivalent per gallon. This was applied at the rate of one and two pounds per acre in five and three gallons of total solution per acre, using Diesel oil as a carrier to three brush conditions.

Description of Study Area: The three brush conditions were man made. In 1949 a study was carried out on these plots to determine if hardwoods could be controlled through cutting operations without the aid of chemicals. The minimum treatment was to remove hardwoods only down to cross tie size (approx. 12" DBH). This gave back the least underbrush. The intermediate treatment removed hardwoods down to cordwood size (approx. 5" DBH). This in turn gave the intermediate brush condition. A maximum treatment of cutting all hardwoods down to 6 feet in height that were interferring with more desirable pine. This treatment by 1960 gave the maximum brush condition. Treatments for the mist blowing tests were superimposed on these plots. Two plots of each treatment were applied to each brush condition. The size of the plots was 4.44 acres for the total plot with a measurement plot of 2.0 acres.

Discussion of Results: Results of this test may be seen in Table 3. From these data it is apparent that there was very little difference between treatments. This

Table 1. 1959 mist blower plots.

Chemical	Rate[1]	Carrier	Hardwood (H) and pine (P) stems per acre									
			Before Treatment		1959		1960		1961		1962	
			H	P	H	P	H	P	H	P	H	P
Weedone 245-T[2]	4-lb. in 5	Oil-water	4020	3500	2480	2700	2780	6140	4920	10540	4060	10940
Weedone 245-T[2]	2-lb. in 5	Oil-water	3300	2720	1280	900	1580	3860	2900	7540	2940	8880
Weedone 245-T[2]	2-lb. in 3	Oil-water	6020	2040	2680	1120	3740	4160	4860	6140	3620	6440
Trinoxol[3]	4-lb. in 5	Oil	2500	3680	940	1300	1280	4860	2580	7600	1820	10080
Trinoxol[3]	2-lb. in 5	Oil	4460	2620	1660	1320	1960	2980	2520	5120	2260	7260
Trinoxol[3]	2-lb. in 3	Oil	4360	3200	2400	2020	2560	4680	3860	7200	8420	8940
ACP-M654[4]	4-lb. in 5	Water	2240	2640	600	560	960	3960	1120	6220	1060	8220
ACP-M654[4]	2-lb. in 5	Water	4640	2160	1460	1740	1700	4720	2720	8680	2000	8800
ACP-M654[4]	2-lb. in 3	Water	3340	2980	1740	1100	2660	4200	2960	5020	2820	7400
ACP-M414[5]	2-lb. in 5	Oil-water	3840	1220	920	420	1540	2340	2420	5120	2180	5960
GC 2, 4, 5-T[6]	4-lb. in 5	Oil-water	3780	1040	560	340	1760	4000	2100	6660	2020	6460
GC 2, 4, 5-T[6]	2-lb. in 3	Oil-water	4180	3380	1660	1180	2320	3900	2960	6680	2680	8420
Weedar 245-T[7]	4-lb. in 5	Water	4400	840	2940	580	3480	1420	4060	3720	3460	4200
Weedar 245-T[7]	2-lb. in 5	Water	3580	800	2740	1100	2720	1660	3080	2560	2920	3340
Weedar 245-T[7]	2-lb. in 3	Water	4520	1740	2020	1560	2320	2620	3260	6100	2680	7740

[1] Pounds of acid equivalent per cent in gallons of total solution.

[2] Four pounds acid equivalent per gallon of butoxy ethanol esters, of 2, 4, 5-T for use in oil-water or water mixture

[3] Four pounds acid equivalent per gallon of butoxy ethanol esters of 2, 4, 5-T. This formation carries no emulsifier.

[4] Two pounds acid equivalent per gallon of emulsifiable acid of 2, 4, 5-T for use in water only.

[5] Four pounds acid equivalent per gallon of an invert emulsion of the butoxy ethanol esters of 2, 4, 5-T.

[6] Four pounds acid equivalent per gallon of Isooctyl ester of 2, 4, 5-T for use in oil-water or water mixture.

[7] 2, 4, 5-T as the amine salt for use in water mixture only.

Table 2. 1959 mist blower plots: Evaluation of tagged sample trees. Treatment date June 1959.

Chemical	Carrier	Rate	Volume	Percent Kill 1960 Hardwood %	Percent Kill 1960 Pine %	Percent Kill 1961 Hardwood %	Percent Kill 1961 Pine %
Weedone 245-T	Oil-water	4-lb.	5 gal.	44	50	54	50
Weedone 245-T	Oil-water	2-lb.	5 gal.	49	0	52	14
Weedone 245-T	Oil-water	2-lb.	3 gal.	50	0	54	0
Trinoxol	Oil	4-lb.	5 gal.	56	41	66	47
Trinoxol	Oil	2-lb.	5 gal.	56	18	64	18
Trinoxol	Oil	2-lb.	3 gal.	42	0	47	0
ACP-M645	Water	4-lb.	5 gal.	85	67	88	67
ACP-M645	Water	2-lb.	5 gal.	48	23	50	23
ACP-M645	Water	2-lb.	3 gal.	34	6	41	7
ACP-M414	Oil-water	2-lb.	5 gal.	64	20	67	25
GC 245-T	Oil-water	4-lb.	5 gal.	75	0	75	0
GC 245-T	Oil-water	2-lb.	3 gal.	50	0	54	0
Weedar 245-T	Water	4-lb.	5 gal.	33	0	38	0
Weedar 245-T	Water	2-lb.	5 gal.	26	0	30	0
Weedar 245-T	Water	2-lb.	3 gal.	23	0	24	0

Hardwood Species: 1. Red Oak, 2. Post Oak, 3. Sweetgum, 4. Hickory.

Table 3. 1960 mist blower plots, Chemical: Non-emulsifiable ester of 2, 4, 5-T. Treatment date June 1960.

Brush Density	Hardwood Stems Per Acre	Pine Stems Per Acre	Rate[1]	Hardwood Percent Kill 1961	Hardwood Percent Kill 1962	Pine Percent Kill 1961	Pine Percent Kill 1962
Maximum	3930	505	2-lb. in 5	55	56	42	39
Maximum	3045	765	2-lb. in 3	44	56	26	30
Maximum	3300	710	1-lb. in 5	53	53	25	12
Maximum	4390	635	1-lb. in 3	44	50	26	32
Average	3666	653		49	54	30	28
Intermediate	3335	715	2-lb. in 5	53	57	42	25
Intermediate	3480	395	2-lb. in 3	55	54	53	37
Intermediate	4075	1150	1-lb. in 5	62	62	41	38
Intermediate	3405	580	1-lb. in 3	47	54	27	31
Average	3573	710		54	57	41	32
Minimum	4165	435	2-lb. in 5	57	62	31	38
Minimum	3980	215	2-lb. in 3	51	58	37	37
Minimum	2295	265	1-lb. in 5	50	55	41	25
Minimum	2500	190	1-lb. in 3	64	61	21	11
Average	3235	276		55	59	32	28

	Hardwood Kill 1961	Hardwood Kill 1962	Pine Kill 1961	Pine Kill 1962
Average for all 2-lb. in 5 gal. plots	55%	58%	38%	34%
Average for all 2-lb. in 3 gal. plots	53%	56%	38%	35%
Average for all 1-lb. in 5 gal. plots	55%	57%	35%	25%
Average for all 1-lb. in 3 gal. plots	49%	55%	25%	24%

[1] This is the number of pounds of acid equivalent per acre in gallons of total solution.

leads us to believe that under conditions such as these where the species composition is primarily made up of sweetgum, post oak, southern red oak, and hickory, we should be able to go below two pounds of acid equivalent per acre and this can be applied either in 3 or 5 gallons total solution. This is also true as far as past treatments are concerned. There was very little difference between the maximum and the minimum treatments. From this it appears that we can treat dense

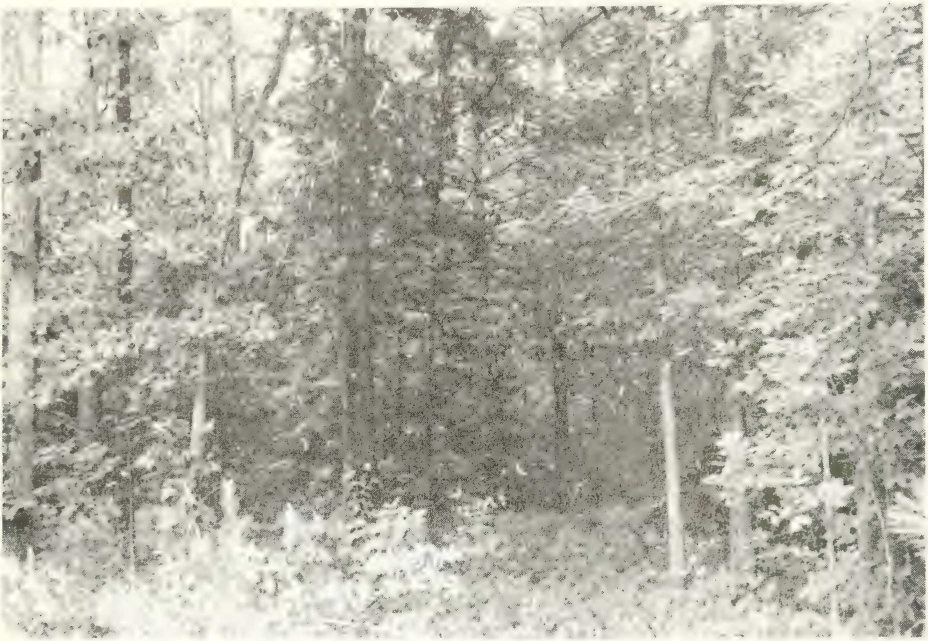

Figure 5. Hardwood overstory and hardwood understory on pine site. The understory can be prepared for underplanting by mist blowing.

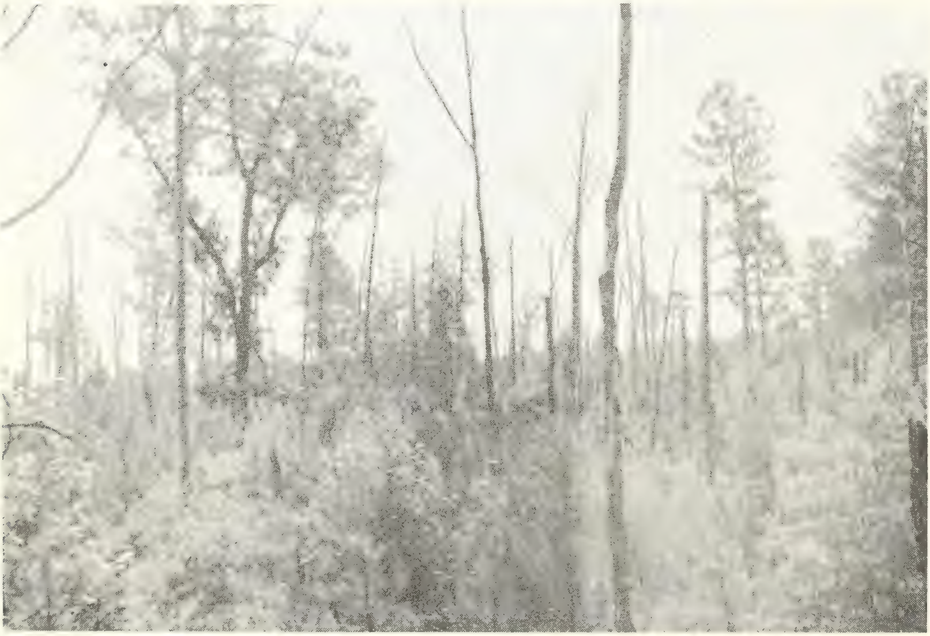

Figure 6. Area similar to Figure 5 four years after underplanting and the overstory removed by injection.

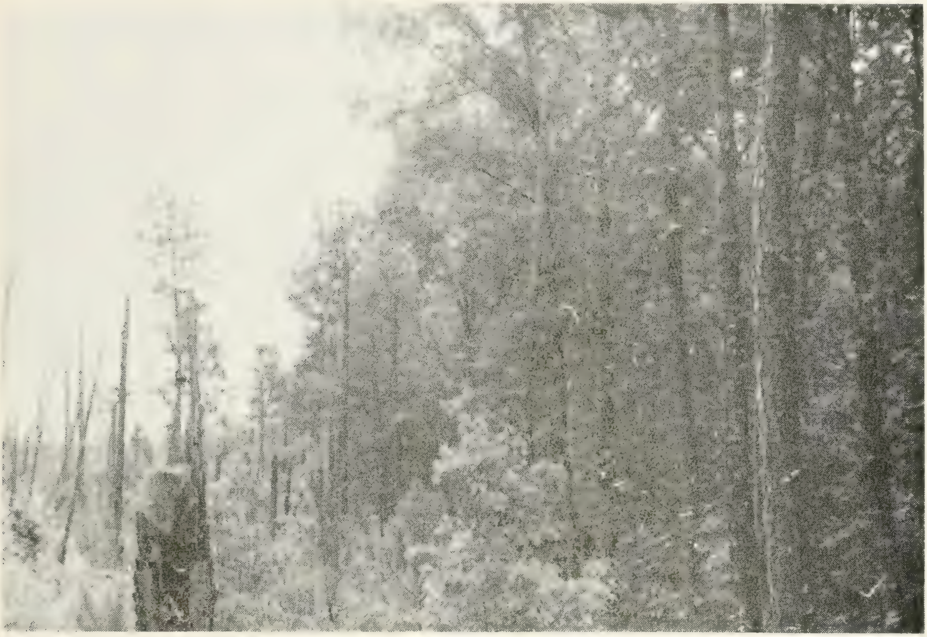

Figure 7. Showing the line between Figure 5 and Figure 6.

brush with three gallons of total solution instead of five. This was the case on these plots, however extreme care will have to be taken to insure complete coverage. With three gallons there is less room for error in coverage than with five. Since the cost of the two gallons of additional carrier would be small it would probably be good insurance for good coverage.

Combination of Treatments

Seldom if ever will mist blowing alone do the complete job that the forest manager wishes to accomplish with chemical brush control. The mist blower should be thought of as one of the several tools that foresters have to maintain pine stands. A combination of one or more tools will probably give the desired results. The combination of fire and mist blowing has been used with success. Controlled burning before spraying has the advantage of reducing the size and density of brush so that complete coverage can be obtained with small volumes. The danger here is not giving all of the brush time to sprout so the foliage application can be applied. Burning after spraying has the advantage of having more fuel on the ground for the fire, but there is the danger of burning too soon before all of the effect of the chemical has been obtained. The use of fire and mist blowing combination will have its place in a herbicide program. Stand conditions will determine if the burn should be before or after spray.

The mist blower-tree injector combination has been used on large areas and will be used a great deal in the future. If we think of the hardwood problem in terms of overstory and understory control then this combination seems to best fit. The mist blower can be used to control the understory, up to 20 to 25 feet high and the overstory can then be removed with the tree injeltor. In all cases the understory should be controlled before the overstory is removed. Desirable reproduc-

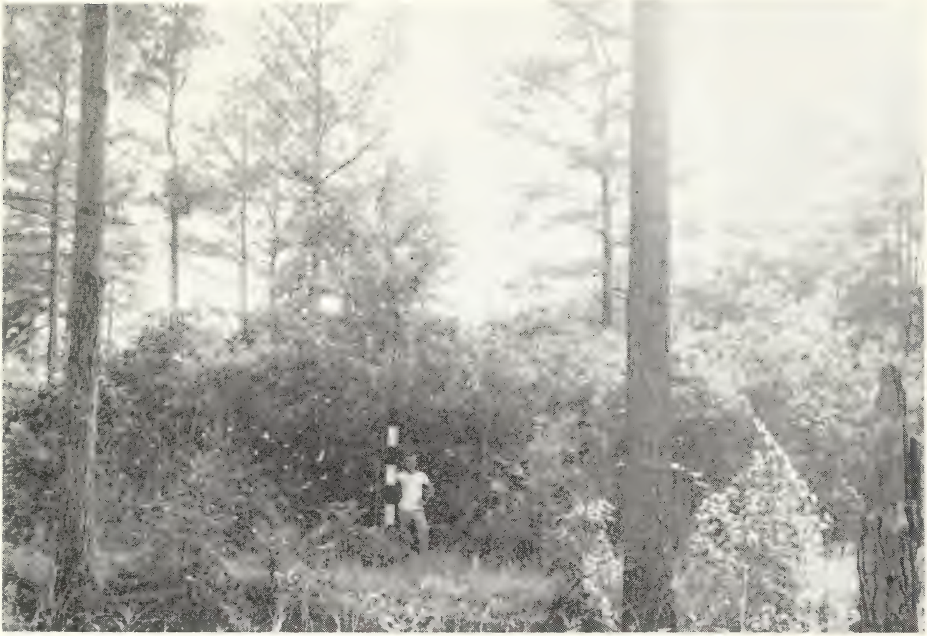

Figure 8. Area in need of mist blowing. Pine overstory with hardwood understory too high and dense for control burning.

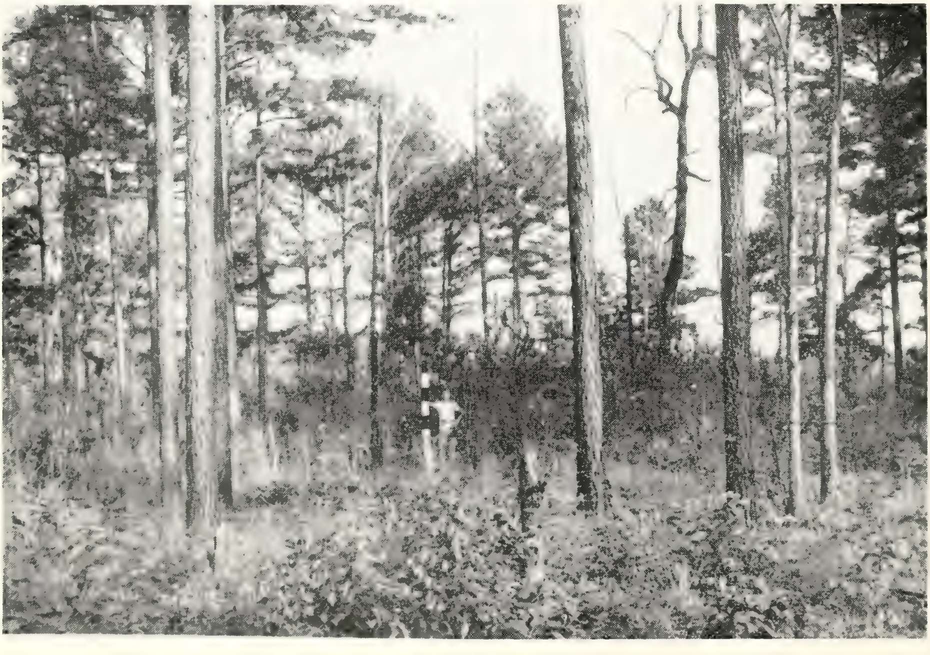

Figure 9. Similar area to Figure 8 one year after treatment with a mist blower.

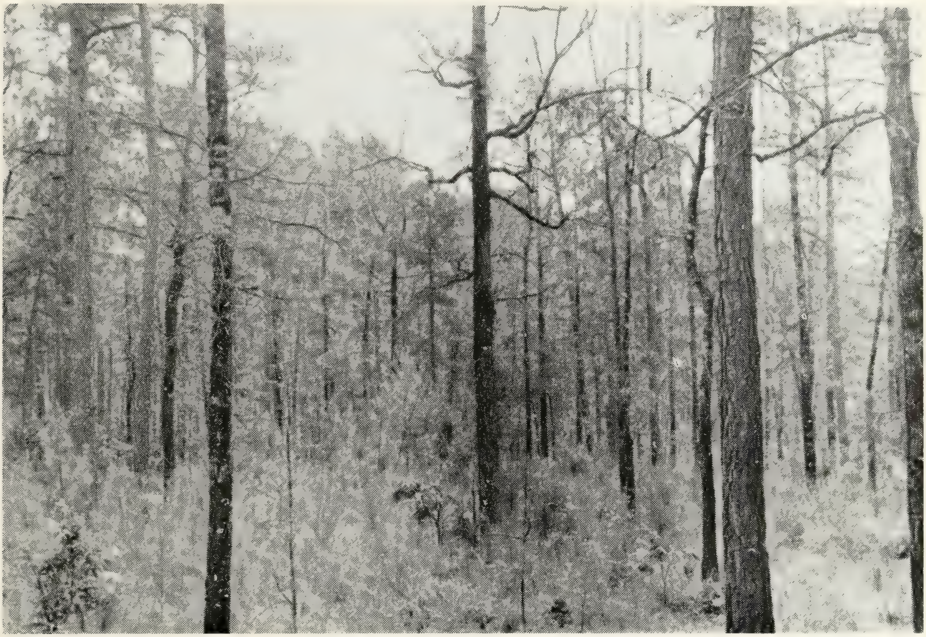

Figure 10. Area that was mist blown to control the hardwood in an understory and three years later the overstory had been injected.

tion should be established in the understory before the overstory is removed to release it. If these treatments are reversed then we are releasing the understory brush which is more difficult to control. This has been done over large areas of the South before some method was developed to treat many small stems per acre at a reasonable cost.

Costs

The cost of mist blowing varies, but has ranged from $7.00 to $10.00 over most of the South. Some of the factors that influence the cost are: The amount of acid applied per acre; the type of carrier used: the total volume of solution applied per acre; size and operating costs of the tractor used to transport the blower; brush conditions of the area treated; the roughness of the terrain; and the number and nature of breakdowns on the job. All of these conditions should be looked at carefully in planning a mist blowing job. Applying two pounds of acid equivalent in an oil-water emulsion at a total volume of five gallons per acre under average brush conditions and on areas where the terrain will not limit the tractor operation we can expect a cost per acre of less than $10.00

Precautions

The hazards of mist blowing cannot be overemphasized. Although the phenoxy compounds are not toxic to human, wildlife, and livestock, they are damaging to most row crops. Care should be exercised at all time to avoid drift to nearby crops. Trees over 25 to 30 feet high should be treated by other means rather than by applying these small droplets of a very active chemical this high in the air. Never mist blow when the wind veolocity is over 10 miles per hour. Crews using the mist blower should be well trained and closely supervised.

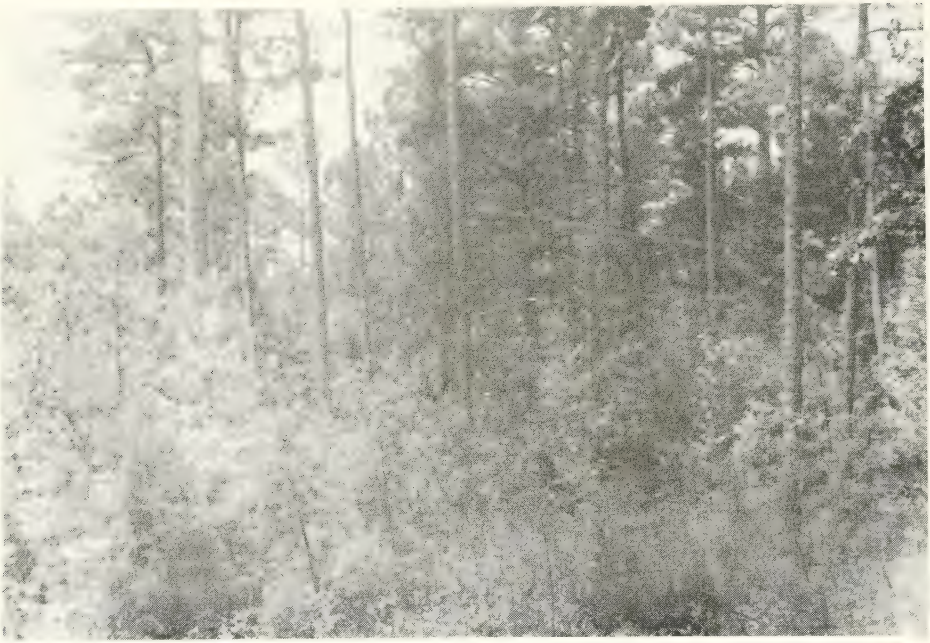

Figure 11. Area similar to that shown in Figure 12 before treatment.

Summary

The primary objective of mist blowing is the removal of dense stands of small undesirable hardwoods (up to 20 or 25 feet high) often found as understories in pine forest. This understory is difficult to control by aerial application because the overstory of pine or hardwood intercepts most of the spray. The mist blower offers a means of treating small blocks of isolated stands that could not be treated economically from the air. This type of treatment can be used to release already established pines that are being overtopped by undesirable hardwoods or can be used as site preparation for underplanting. It has a limitation in so far as natural regeneration is concerned in that it does little to prepare a seedbed and the resurge of hardwoods may come before the seedlings become established and obtain a favorable position.

From the tests at the Mississippi State University Experiment Station, our present recommendations are to apply from 1½ to 2 pounds of acid equivalent per acre in a total solution of 5 gallons. If pine release is the primary objective then an oil-water emulsion of 10% oil by volume should be used. This oil percent should be increased as the growing season progresses or during long periods of prolonged drouth. Where site preparation for

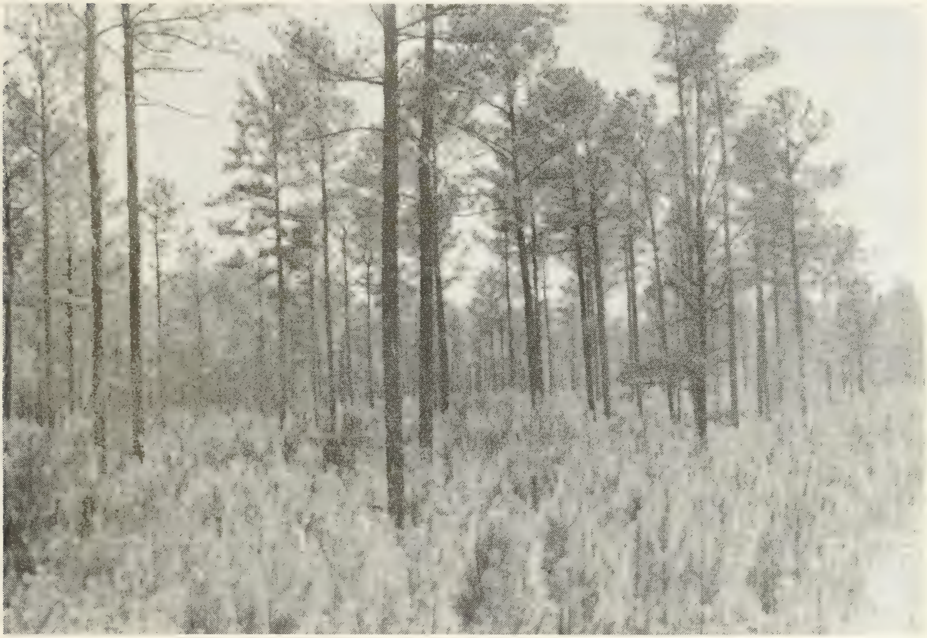

Figure 12. Area after a combination of treatments: Control burning to reduce the size of understory, mist blown after the resurge of hardwoods, injected to remove the hardwoods that were in the overstory.

planting is the objective, then an oil carrier should be used.

With good control over the amount of solution applied per acre and extreme care to obtain complete coverage acceptable results can be expected from mist blowing providing that the site and species composition is favorable. These results will range from 45 to 60 percent control of the hardwood brush. Pine damage in release work can be held at a minimum if an oil-water emulsion is used and a direct blast from the outlets can be avoided.

It should be remembered that the mist blower is not a "cure-all" for all hardwood problems but is a tool and in most cases will have to be used in combination with other techniques.

These opinions of the writer are based not only on the formal plot work but on experience gained in 8 years of using the mist blower under a variety of conditions. Most of this work, both research and practical, was conducted in the "interior flatwoods" section of Mississippi. These comments may have to be adjusted to fit your area. However, the principle will remain the same even if the technique has to be adjusted.

BULLETIN 693 July 1964

1963 Population Estimates For Mississippi Counties

By

ELLEN S. BRYANT

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Summary and Implications

The year 1963 brought Mississippi and most of its counties continuing, but somewhat more conservative, growth rates than were recorded for the first two years of the decade. Most of the growth was added to the already urbanized and industrial areas of the state, confirming an often stated hypothesis that growth begets growth. Large urban complexes seem to have a proclivity for consistent, long-range growth. A few of the larger urbanized counties, however, did not register sizeable gains or had only nonwhite growth during the 1960 to 1963 estimate period. Such deviations may be temporary readjustments which will cancel out over a longer period of time, or it is possible that they may be only concealing urban growth behind a screen of high rural loss.

Many small scale fluctuations in size tend to characterize population trends in the smaller counties of the state. Some part of these may be an artifact of the estimating procedure, but quite probably they reflect an ongoing process of population redistribution and adjustment to changing economic opportunities.

While white growth is far in excess of the nonwhite and seems to corporate both natural increase and net inmigration, growth of the nonwhite sector is also becoming evident in many parts of the state. In the majority of the growing counties the trend is for both white and nonwhite growth, with the white increases in sufficient excess to increase the white to nonwhite population ratio.

1963 POPULATION ESTIMATES FOR MISSISSIPPI COUNTIES

By ELLEN S. BRYANT

Estimates of Mississippi's county populations reached a new high total of 2,290,108 persons in mid-1963.[1] The continuing growth trend has added another 1.4 percent to the state's population since mid-1962 for a cumulative increase of 5.1 percent since the 1960 Census was taken.

The year's increase, totaling somewhat over 30,000 persons represents approximately a four-to-one ratio of white to nonwhite growth. The white estimate of 1,348,880 persons resulted from 2.1 percent gain since 1962 and the nonwhite figure of 941,300 accrued from a 0.5 percent gain over the previous year. Since 1960 the white population has had an estimated 7.3 percent growth and the nonwhite a 2.3 percent increment.

While the state's estimated total growth rate was almost identical to the national growth rate during the approximate three-year period, within the state it was somewhat reduced in the 1962-63 period over what it had been between 1961 and 1962. For the earlier year the estimated growth rates were 2.1 percent for that total, 2.8 percent for the white, and 1.0 percent for nonwhites—or from 0.5 to 0.7 percent higher than for the most recent period.

The estimated total gains since 1960 are approximately what the state would have experienced from natural increase (births minus deaths) had there been no movement out of or into the state. However, as the differential white-nonwhite growth rates indicate, the total change resulted from a concurrent net outmigration of about 47,000 nonwhites and an inmovement of about 40,000 whites for an estimated net migration loss over the three-year period of about 6,500 individuals. See Table 1. This net replacement of nonwhite with white population was also a factor in the 1961 and 1962 estimates of Mississippi county population trends.

The 1963 gains in Mississippi's population were accompanied by increases in both employment and business activity. According to the Business Research Station at Mississippi State University, state business in general "moved up in the first five months, leveled out for the next four months, and then moved upward again in the last three months" for a net gain of 7 to 8 percent during the year.[2] Jobs in non agricultural employment increased by 16.6 thousand between 1962 and 1963, representing a percentage growth of 3.9 percent. This rate was slightly below that for the 1961-62 period when nonagricultural employment rose by 4.2 percent.

Sharpest 1963 employment increases were located in durable goods, manufacturing petroleum products, and medical and health services.[3] These indicators of economic growth both stubstantiate and explain a large part of the general state pattern of growth, and suggest that changes are occuring in the occupational structure of the state in the direction of the national mode with higher propor-

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[1] Estimated by Division of Sociology and Rural Life, Mississippi State University. The Bureau of Census 1963 estimate of Mississippi population was 2,290,000. See U.S. Bureau of the Census, **Current Population Reports.** Series P-25, No. 273, November 4, 1963.

[2] Louis M. O'Quinn, "Business in 1963," **Mississippi Business Review,** 25 (8): 8 (February 1964).

[3] Mississippi Employment Security Commission, **Mississippi Labor Market - Annual Supplement,** XV(2 supp.): S-2 (March 1964).

Table 1. Estimated net migration, Mississippi, April 1, 1960 to July 1, 1963.

Mississippi population	1960 population	Natural increase	Total expected population*	Estimated average 1963 population	Estimated net migration**
Total	2,178,141	118,512	2,296,653	2,290,180	—6,473
White	1,257,546	50,907	1,308,453	1,348,880	40,427
Nonwhite	920,595	67,605	988,200	941,300	—46,900

Data sources: U.S. Bureau of the Census and Mississippi State Board of Health.
*Column 1 plus column 2.
**Column 4 minus column 3.

Table 2. Twelve counties with highest estimated numerical population gains, 1960 to 1963.

The twelve top rank counties	Estimated net increase 1960 to 1963	1960*	
		Size rank	Percent urban
Hinds	12,640	1	80.7
Jackson	11,468	6	61.3
Lauderdale	6,500	4	73.6
Harrison	5,900	2	77.4
Lowndes	5,860	10	53.1
Forrest	3,870	8	74.0
Lee	3,750	14	42.4
Rankin	3,730	17	14.8
Pearl River	3,500	31	35.0
De Soto	3,420	29	0.0
Tate	3,330	45	47.4
Bolivar	3,160	7	18.7

*U.S. Bureau of the Census data.

tions is the professional service and industrial occupations.

County Trends

Among the 82 counties, population trends were mixed, but in general population growth was well distributed throughout the state. The 1963 estimates showed total population growth for 56 counties. The majority of these, 36, had estimated increases of 5 percent or better between 1960 and 1963. Nineteen counties scored net losses and seven remained relatively stable. The proportion growing is thus relatively the same as in 1962 when 59 counties showed net gains.[4] However, during 1963 there was a downward shift in some of the southwest counties while in the northeast growth spread out to include several previously declining counties.

Urban Growth: County growth differentials in 1963 continue to be related to increasing urbanization and industrial growth in many areas of the state. Only six Mississippi counties — Hinds, Hancock, Jackson, Lowndes, Lauderdale and Rankin — have recorded uninterrupted growth gains since 1950. These six are all part of developing industrial complexes and were either 50 percent or more urban in 1960 or were located adjacent to overflow urban areas.

Table 2 further substantiates the industrial and urban nature of population growth in Mississippi. Here, in a rank order listing of counties according to their numerical contributions to population growth in Mississippi, we find (1) there is a duplication of all the counties experiencing continuous growth since 1950, except Hancock county; (2) the first six in the list, together contributing more than 40 percent of the state's 1960 to 1963 growth, were all more than 50 per-

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[4] Ellen S. Bryant, **Mississippi County Population Estimates, 1962,** Bulletin 670. State College: Mississippi State University Agricultural Experiment Station, August 1963.

Table 3. Twelve counties with highest estimated rates of population gain, 1960 to 1963.

The twelve top rank counties	Estimated net growth rate, 1960 to 1963	1960*	
		Size rank	Percent urban
Jackson	20.7	6	61.3
Tishomingo	19.8	60	0.0
Covington	18.7	62	0.0
Tate	18.4	45	18.0
Pearl River	15.6	31	35.0
Itawamba	15.1	57	0.0
Hancock	14.7	59	36.1
De Soto	14.3	29	0.0
Rankin	10.9	17	14.8
Smith	10.9	58	0.0
Tippah	10.8	56	17.7
Union	10.0	43	27.2

*U.S. Bureau of the Census data.

cent urban in 1960; (3) the total list of twelve, which includes all counties which increased by 3000 or more since 1960, contributes 60 percent to the state's net growth; (4) the often observed phenomenon for size to attract population growth is demonstrated by the fact that seven of the ten counties ranked largest in 1960 are included among the twelve with largest growth; and (5) the increases in the six lower-ranked counties, which in 1960 were less than 50 percent urbanized and of a relatively low size rank, can be explained largely in terms of unusual economic conditions. Lee county, for instance, has for many years made a concerted effort to attract new industry; Rankin comprises the eastern outskirts of the city of Jackson; Pearl River is the site of recent NASA installations; DeSoto, with no 1960 urban population, is located directly south of Memphis, Tennessee; and Tate, directly, south of DeSoto, is highly urbanized and may be benefitting from a newly constructed interstate highway which cuts through it.

Not all of the state's highly urbanized and high size rank counties have registered sizeable net growth for the first three years of the new decade, although it is probable that their urban centers have been growing. Adams, Washington, and Jones counties, all of which were more than 50 percent urban in 1960, show up with slight losses for the three years since 1960, losses which for the first two disguise small nonwhite increases. Leflore county, which ranked 9 in size and 43.3 percent urban in 1962, showed a small two percent growth between 1960 and 1963, most of which was white. Jones and Washington ranked 5 and 3 in size in 1960, and Adams was 15.

Five of the twelve counties with highest estimated numerical growth are also included among the twelve with highest rates of gain. See Table 3. However, only one of the top ten in size rank is included here. Those duplicated tend to be experiencing new and unusual growth stimuli. Three in the high growth group are coastal counties. Six ranged between thirteen and eighteen thousand in size in 1960, four had no urban population in 1960. In contrast with the group in Table 2, this listing accounts for only 34 percent, or half as much, of the total state growth. The difference emphasizes the importance of net numerical growth and the need for caution in interpreting high growth rates. Where the population base is small the addition or subtraction of a few persons can be translated into a sizeable percent of change. The inclusion of so many small rural counties among those with high growth rates raises questions concerning the meaning and permanence of some of this growth. For instance, is the increase tied to new permanent industrial activity or the temporary return of earlier outmigrants? However, of the whole group in Table 3, Jackson, Covington, Hancock, Rankin, and Tippah have registered a continuous upward trend since 1960, and three of these belong to established urban complexes.

Irregular Trends: The year-by- year county estimates suggest a continuing rearrangement in the short-term distributions of some of the state's population. Almost all of the counties have shown fluctuations between growth and loss patterns since the 1960 Census. However, in nearly half, the up and down variations have amounted to less than 500 persons, and less than half a dozen show variations which exceed 2000. While part of the variation (particularly the smaller ones) may be artifacts of the method, or distortions resulting from inconsistencies in recording vital data, it is very likely that most reflect a fluid internal migration pattern which is continually responding to the pushes and pulls of irregular economic growth.

A significant consideration in looking at a set of population trend figures is to locate long-range, permanent trends. The total 1960 to 1963 estimate period shows definite growth patterns for most Mississippi counties in spite of the yearly fluctuations. Population growth in each county is probably an individual story, developing out of a combination of social and economic factors which operate not only within the county but in the state, the south, and in the nation as a whole. Economic growth in the larger area may effect population loss in the smaller, or curtailment at the national level may result in an accumulation of population at the local levels. On the other hand local developments may be such as to operate independently of the larger. Another factor which may cause irregular changes in the population trends in Mississippi's counties are the frequently contradictory white and nonwhite movements which are averaged and disguised is the total estimates. Thus while short term irregularities can be disturbing they should be expected, and it is the long range trend that adds up to significant change.

White and Nonwhite Differences: Throughout the state the tendency for white growth to exceed nonwhite growth can again be observed in the population estimates. Of the state's 82 counties, 62 experienced white growth, but only 48 had increases in nonwhite. Seventeen counties lost in net white numbers, but 34 lost nonwhites. Furthermore, within the individual counties with both white and nonwhite growth, the white population tended to contribute higher proportions to the increment than did the nonwhites. This tended to be true even in counties which were more than half nonwhite in 1950. The cumulative effects of color growth differentials for counties can be seen in Table 1, giving state migration estimates.

Nevertheless Mississippi's nonwhite population is beginning to grow after having been in continuous decline since 1940. In spite of net migration losses, nonwhites were beginning to retain part of their natural increase to the extent that in twenty-two of the counties the proportion of nonwhites is climbing. To a certain extent the increasing nonwhite percents may be reflecting a trend which is redistributing nonwhites to areas where they are less concentrated. For instance, of the counties increasing their nonwhite proportions, 17 were less than 50 percent nonwhite in 1960 and 13 were about one-third or less nonwhite.

A great deal of the nonwhite growth seems to be complementary to the total county growth patterns. Most of the counties experiencing total growth, experienced both white and nonwhite growth. Table 4 indicates the relationship between total and nonwhite growth. Counties with total growth rates in excess of 5 percent had the highest proportions with both high to medium and low rates of nonwhite growth, and the smallest proportions with no nonwhite growth. It is only the counties with no net change, or loss, which tend to have a large majority losing nonwhites. One might conclude that a growing Mississippi economy tends to absorb both white and nonwhite population growth.

Estimating Procedure

The population estimates in this report were computed by the vital rates method.[5] Based on the assumption that changes in the numbers of births and deaths are related to changes in the size of the population, the county estimates are computed by relating births and deaths to population size through the medium of trend and race-adjusted county birth and death rates. Birth and death characteristics are probably the most stable and direct demographic indicators of short term population trends available. They are, of course, inaccurate to the extent that there is unknown variation in the vital rates or inaccuracy in the re-recording of vital data. Furthermore the age structure of the population in a given locality will influence whether changing numbers of births and deaths means changing birth or death rates or actual changes in population size.

In computing this set of estimates, it was necessary to adjust the figures in two counties for white estimates and in seven for the nonwhite estimates. The method used was a weighted averaging of the birth and death population estimates. For instance, counties known to have high proportions past the child bearing ages were more heavily weighted with the estimates computed by dying characteristics so as to offset the distortion to the birth rate made by the addition of a few families in their reproductive cycles.

These vital rates county estimates, it should be noted, are methodologically tied to the Bureau of Census state estimate through the procedure of computing estimated changes in county and birth and death rates. Thus the closeness of the two state estimates is not entirely coincidenal (See Footnote 1). However, the state estimate reported here results from a summation of separate county estimates of white and nonwhite components. This procedure is hazardous in that small errors at the county level can be compounded to a sizeable state error. The closeness of the summed county white and nonwhite estimates is strong evidence of both the validity and reliability of the vital rates method.

Table 4. Nonwhite and total county population growth, 1960 to 1963 estimates.

Extent of nonwhite population growth	Percent of Mississippi Counties with Total Populations		
	Growing 5% or more	Growing less than 5%	Decreasing or stable
Only nonwhite Growth	3	10	35
Medium to High Growth Rates*	56	40	0
Low Growth Rates**	19	5	0
No Nonwhite Growth	22	45	65
Total	100	100	100
Number of counties:	(36)	(20)	(26)

*Nonwhite growth rates at least 50 percent of the white rates.

**Nonwhite growth rates less than half of the white rates.

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[5] For details of this method see Donald J. Bogue, "A Technique for Making Extensive Population Estimates," **Journal of American Statistical Association**, 45 (June 1950), 149-163.

Table 5. Estimated Mississippi county total populations, 1961 to 1963*, and trends since 1950.

Mississippi Counties	Population				Percent Change	
	1963	1962	1961	1960**	60-63	50-60**
	2,290,180	2,258,130	2,212,580	2,178,141	5.1	
Adams	37,520	38,570	37,520	37,730	—0.6	17.0
Alcorn	26,840	27,300	26,120	25,282	6.2	—6.9
Amite	17,100	15,320	14,920	15,573	9.8	—19.1
Attala	22,520	20,650	22,080	21,335	5.6	—19.9
Benton	8,160	7,800	7,980	7,723	5.7	—12.2
Bolivar	57,620	56,330	56,950	54,464	5.8	—13.6
Calhoun	16,630	16,390	16,840	15,941	4.3	—13.2
Carroll	12,030	13,190	11,770	11,177	7.6	—27.9
Chickasaw	17.610	17,720	16,850	16,891	4.3	—10.9
Choctaw	7,850	8,500	8,320	8,423	—6.8	—23.5
Claiborne	9,800	10,250	10,660	10.845	—9.6	—9.2
Clarke	17,070	15,550	15,990	16,493	3.5	—14.8
Clay	19,760	19,200	19,210	18,933	4.4	6.6
Coahoma	48.500	49,620	48,980	46,212	5.0	—6.4
Copiah	27,250	27,790	27,320	27,051	0.7	—11.3
Covington	16.190	14,270	13,690	13,637	18.7	—15.0
De Soto	27,310	24,330	24,650	23,891	14.3	—2.9
Forrest	56,590	55,550	56,250	52,722	7.3	17.0
Franklin	9,230	9,720	9,430	9,286	—0.6	—15.0
George	11,130	11,120	11,480	11,098		10.8
Greene	8,350	8,320	8,170	8,366		—1.8
Grenada	19,120	19,030	19,620	18,409	3.9	—2.2
Hancock	16,100	14,920	14,760	14,039	14.7	18.1
Harrison	125,390	130,070	118,390	119,489	4.9	42.1
Hinds	199,680	198.680	189,840	187,045	6.8	31.6
Holmes	27,040	25,700	28,300	27,096		—18.6
Humphreys	19,380	19,220	19,500	19,093	1.5	—17.4
Issaquena	2,690	2,350	3,080	3,576	—24.8	—28.0
Itawamba	17.350	15,590	14,700	15,080	15.1	—12.4
Jackson	66,990	62,930	57,330	55,522	20.7	76.8
Jasper	17,130	19,640	17,340	16,909	1.3	—10.6
Jefferson	10,150	9,750	10,640	10,142		—10.3
Jefferson Davis	13,430	13,540	12,940	13,540	—0.8	—12.6
Jones	59,070	59,980	60,670	59,542	—0.8	4.0
Kemper	11,670	10,750	13,000	12,277	—4.9	—22.8
Lafayette	22,170	21,250	22,550	21,355	3.8	—6.3
Lamar	14,890	15,130	14,510	13,675	8.9	3.4
Lauderdale	73,620	70,500	69,710	67,119	9.7	4.6
Lawrence	9,360	9,840	9,630	10,215	—8.4	—19.2
Leake	17,390	19,570	17,960	18,660	—6.8	—13.7
Lee	44,340	41,330	41,560	50,589	9.2	6.2
Leflore	48.100	48,100	48,430	47,142	2.0	—9.0
Lincoln	26,170	28,180	27,120	26,759	—2.2	—4.1
Lowndes	52,500	50,200	47,790	46,639	12.6	23.2
Madison	33,310	33,230	32,780	32,904	1.2	—2.8
Marion	21,440	23,470	24,540	23,293	—8.0	—2.8
Marshall	25,120	25,020	24,250	24,503	2.5	—2.4
Monroe	36,500	33,550	31,970	33,953	7.5	—7.1
Montgomery	13,350	15,020	15,130	13,320		—7.9
Neshoba	21,460	21,510	20,220	20,927	2.5	—18.7
Newton	20,620	20,680	21,010	19,517	5.7	—14.0
Noxubee	17,540	17,080	16,730	16,826	4.2	—16.0
Oktibbeha	28,220	26,120	27,160	26,175	7.8	6.5
Panola	31,220	31,590	29,230	28,791	8.4	—7.9
Pearl River	25,910	23,280	22,350	22,411	15.6	8.6
Perry	8,530	8,140	8,120	8,745	—2.5	—4.0
Pike	34,870	35,820	36,290	35,063	—0.6	
Pontotoc	18,820	19,180	18,150	17,232	9.2	—13.8

Table 5. Continued

Mississippi Counties	Population 1963	1962	1961	1960**	Percent Change 60-63	50-60**
Prentiss	19.280	17,650	18,500	17,949	7.4	—9.4
Quitman	23,070	21,660	21,510	21,019	9.8	—18.8
Rankin	38,050	36,230	35,460	34,322	10.9	18.8
Scott	23.050	22,090	20,890	21,187	8.8	—2.3
Sharkey	10,550	11,440	11,340	10,738	—1.7	—16.8
Simpson	22,240	21,700	20,060	20,454	8.7	—6.3
Smith	15,860	14,250	14,230	14,303	10.9	—14.6
Stone	6,630	8,680	7,190	7,013	—5.5	12.0
Sunflower	48,190	48,730	47,760	45,750	5.3	—18.3
Tallahatchie	24,920	24,580	24,390	24,081	3.5	—21.0
Tate	21,470	19,060	17,980	18,138	18.4	0.7
Tippah	16,720	16,390	15,220	15,093	10.8	—13.9
Tishomingo	16,640	14,620	15,010	13,889	19.8	—10.6
Tunica	16,960	17,230	16,920	16,826	0.8	—22.3
Union	20,800	18,830	18,040	18,904	10.0	—6.7
Walthall	13,450	12,780	13,390	13,512		—13.2
Warren	44,160	43,570	41,900	42,406	4.1	6.5
Washington	77,180	76,480	78,660	78,638	—1.9	11.5
Wayne	16,180	15,820	16,220	16,258		—4.4
Webster	10,390	10,460	11,180	10,580	—1.8	—8.8
Wilkinson	12,920	12,080	13,160	13,235	—2.4	—6.2
Winston	19,560	19,980	18,310	19,246	1.6	—13.4
Yalobusha	12,730	12,400	12,260	12,502	1.8	—17.7
Yazoo	33,480	33,990	30,470	31,653	5.8	—11.4

*Midyear.
**Bureau of the Census enumeration.
Estimates are rounded.

Table 6. Estimated Mississippi County White Populations, 1961 to 1963, and Trends Since 1950.

Mississippi Counties	Population 1963	1962	1961	1960**	Percent Change 60-63	50-60**
	1,348,880	1,321,140	1,284,660	1,257,546	7.3	5.8
Adams	18,560	19,340	18,860	19,035	—2.5	17.8
Alcorn	23,380	23,930	22,760	21,949	6.5	—10.0
Amite	8,150	6,940	6,780	7,130	14.3	—19.2
Attala	13,420	11,840	12,620	11,789	13.8	—21.8
Benton	3,710	4,260	4,590	4,114	—9.2	—16.8
Bolivar	19,570	18,880	17,600	17,521	11.7	—11.8
Calhoun	12.840	11,910	12,300	11,595	10.7	—17.6
Carroll	5,550	6,270	5,020	4,677	18.7	—29.8
Chickasaw	10,620	10,270	10,380	10,380	2.3	—1.4
Choctaw	5,310	6,240	5,890	5,903	—10.0	—23.1
Claiborne	2,840	2,720	2,660	2,600	9.2	—13.6
Clarke	11,580	9,120	9,710	10,001	15.8	—12.9
Clay	9,980	7,920	8,980	9,214	8.3	20.3
Coahoma	15,160	16,140	16,110	14,630	3.6	6.8
Copiah	12,790	12,910	13,550	12,992	—1.6	—8.6
Covington	10,740	9,360	8,960	8,896	20.7	—17.8
De Soto	12,710	10,890	9,730	9,248	37.4	14.5
Forrest	41,770	40,270	40,830	37,970	10.0	18.3
Franklin	5,710	5,750	5,580	5,486	4.1	—17.2
George	9,450	9,540	10,230	9,811	—3.7	11.7
Greene	6,780	6,420	6,340	6,443	5.2	—4.0
Grenada	10,320	10,230	10,160	9,352	10.4	3.9
Hancock	13,140	12,110	12,440	11,784	11.5	19.6
Harrison	105,210	109,700	99,840	100,233	5.0	41.9

Table 6. Continued

Mississippi	Population				Percent Change	
Counties	1963	1962	1961	1960**	60-63	50-60**
Hinds	117,020	115,540	112,440	112,205	4.3	43.4
Holmes	7,860	7,170	7,620	7,595	3.5	—13.9
Humphreys	6,090	6,260	5,860	5,758	5.8	—17.9
Issaquena	850	690	1,280	1,176	—27.7	—27.3
Itawamba	16,430	14,640	13,780	14,206	15.7	—12.7
Jackson	55,350	50,760	46,180	44,658	23.9	81.1
Jasper	9,030	10,190	8,750	8,402	7.5	8.6
Jefferson	3,250	3,280	2,730	2,489	30.6	—13.8
Jefferson Davis	6,800	5,900	5,950	6,126	11.0	—11.1
Jones	43,890	43,460	44,890	44,095		4.5
Kemper	4,900	4,320	5,350	4,828	1.5	—25.3
Lafayette	14,710	14,140	15,590	14,110	4.3	—4.1
Lamar	12,720	12,290	12,080	11,443	11.2	2.9
Lauderdale	50,340	49,170	45,410	43,635	15.4	7.0
Lawrence	6,120	6,380	6,470	6,354	—3.7	—19.4
Leake	9,850	11,440	10,320	10,559	—6.7	—15.2
Lee	32,670	30,330	31,460	30,300	7.8	9.9
Leflore	17,400	18,210	18,200	16,699	4.2	1.3
Lincoln	18,230	20,140	18,610	18,407	—1.0	—1.6
Lowndes	33,520	31,990	29,910	28,871	16.1	48.5
Madison	10,480	11,120	9,500	9,267	13.1	3.8
Marion	13,840	14,920	16,550	15,408	—10.2	—1.1
Marshall	7,550	7,550	7,130	7,264	3.9	—1.5
Monroe	25,260	22,460	20,290	21,932	15.2	—3.9
Montgomery	8,080	9,280	8,380	7,349	9.9	—10.9
Neshoba	15,800	16,210	14,930	15,026	5.2	—21.2
Newton	13,700	14,420	14,670	12,950	5.8	—12.7
Noxubee	5,130	4,620	5,000	4,724	8.6	—7.7
Oktibbeha	15,700	14,270	15,890	14,727	6.6	14.9
Panola	14,130	13,580	12,660	12.565	12.5	—8.8
Pearl River	20,480	18,450	17,350	17,221	18.9	6.2
Perry	5,820	6,100	6,110	6,333	—8.1	—8.2
Pike	19,870	20,170	20,690	19,655	1.1	1.2
Pontotoc	15,360	15,620	14,960	13,946	10.1	—13.8
Prentiss	16,830	15,330	16,060	15,763	6.8	—9.8
Quitman	9,200	8,880	7,880	7,715	19.2	—24.2
Rankin	23,540	21,330	22,590	21,504	9.5	41.4
Scott	14,640	14,120	13,850	13,050	12.2	6.0
Sharkey	2,980	3,680	3,380	3,247	—8.2	—12.4
Simpson	15,160	14,010	12,300	13,254	14.4	—8.9
Smith	12,060	10,880	10,980	11,056	9.1	—17.2
Stone	4,870	6,840	5,490	5,302	—8.1	8.2
Sunflower	14,820	15,500	16,250	14,730	0.6	—17.6
Tallahatchie	8,930	8,770	8,570	8,580	4.1	—22.5
Tate	9,280	8,190	7,830	7,696	20.6	0.7
Tippah	13,500	13,730	12,290	12,337	9.4	—12.7
Tishomingo	15,930	13,850	14,280	13,210	20.6	—10.4
Tunica	3,520	3,640	4,080	3,505		—11.1
Union	17,510	15,850	15,100	15,592	12.3	—6.2
Walthall	7,420	7,020	7,370	7,412		—11.7
Warren	24,440	22,980	22,270	22,447	8.9	15.0
Washington	33,710	35,120	33,820	35,239	—4.3	50.4
Wayne	9,950	10,140	10,680	10,449	—4.8	—3.2
Webster	7,540	7,450	7,980	7,938	—5.0	—11.0
Wilkinson	3,990	2,990	3,660	3,807	4.8	—12.6
Winston	10,680	12,080	10,140	10,853	—1.6	—16.1
Yalobusha	7,080	6,960	6,750	6,962	1.7	—18.4
Yazoo	13,780	13,290	12,320	12,862	7.1	—5.6

*Midyear. **Bureau of the Census enumeration. Estimates are rounded.

Table 7. Estimated Mississippi County Nonwhite Populations, 1961 to 1963*, and Trends Since 1950.

Mississippi Counties	Population				Percent	Change
	1963	1962	1961	1960**	60-63	50-60**
	941.300	936,990	927,920	920,595	2.3	—7.0
Adams	18,960	19,230	18,660	18,695	1.4	16.1
Alcorn	3,460	3,370	3,350	3,333	3.8	—14.6
Amite	8,950	8,380	8,130	8,443	6.0	—19.1
Attala	9,100	8,810	9,460	9,546	—4.7	—17.5
Benton	4,450	3,540	3,400	3,609	23.3	—6.3
Bolivar	38,050	37,540	39,350	36,943	3.0	—14.4
Calhoun	3,790	4,480	4,540	4,346	—12.8	1.3
Carroll	6,480	6,920	6,750	6,500		—26.4
Chickasaw	6,990	6,970	6,580	6,511	7.4	—22.7
Choctaw	2,540	2,260	2,420	2,520	0.8	—24.3
Claiborne	6,960	7,530	8,010	8,245	—15.6	—7.7
Clarke	5,490	6,430	6,280	6,492	—15.4	—17.6
Clay	9,780	11,280	10,230	9,719	0.6	—3.7
Coahoma	33,340	33,480	22,880	31,582	5.6	—11.4
Copiah	14,460	14,880	13,780	14,059	2.9	—13.7
Covington	5,450	4,910	4,730	4,741	15.0	—9.1
De Soto	14,600	13,440	14,920	14,643		—11.4
Forrest	14,820	15,280	15,420	14,752		13.8
Franklin	3,520	3,970	3,840	3,800	—7.4	—11.7
George	1,680	1,580	1,250	1,287	30.5	4.5
Greene	1,570	1,900	1,830	1,923	—18.4	27.9
Grenada	8,800	8,800	9,460	9,057	—2.8	—7.9
Hancock	2,960	2,810	2,330	2,255	31.3	10.6
Harrison	20,180	20,370	18,550	19,256	4.8	43.5
Hinds	82,660	83,140	77,400	74,840	10.4	17.1
Holmes	19,180	18,530	20,680	19,501	—1.6	—20.3
Humhpreys	13,290	12,960	13,730	13,335		—17.2
Issaquena	1,840	1,660	1,800	2,400	—23.3	—28.3
Itawamba	920	950	910	874	5.3	—6.7
Jackson	11,640	12,170	11,150	10,864	7.1	61.3
Jasper	8,100	9,450	8,590	8,507	—4.8	—12.5
Jefferson	6,900	6,470	7,910	7,653	—9.8	—9.1
Jefferson Davis	6,630	7,640	6,990	7,414	—10.6	—13.9
Jones	15,180	16,520	15,780	15,447	—1.7	—2.9
Kemper	6,770	6,430	7,650	7,449	—9.1	—21.0
Lafayette	7,460	7,110	6,960	7,245	3.0	—10.4
Lamar	2,170	2,840	2,430	2,232	—2.8	6.0
Lauderdale	23,280	21,330	24,300	23,484	—0.9	0.4
Lawrence	3,240	3,460	3,160	3,861	—16.1	—18.9
Leake	7,540	8,130	7,640	8,101	—6.9	—11.6
Lee	11,670	11,000	10,100	10,289	13.4	—3.5
Leflore	30,700	29,890	30,230	30,443	0.8	—13.8
Lincoln	7,940	8,040	8,510	8,352	—4.9	—9.1
Lowndes	18,980	18,210	17,880	17,768	6.8	—3.5
Madison	22,830	22,110	23,280	23.637	—3.4	—5.2
Marion	7,600	8,500	7,990	7,885	—3.6	—6.0
Marshall	17,570	17,470	17,130	17,239	1.9	—2.8
Monroe	11,240	11,090	11,680	12,021	—6.5	—12.3
Montgomery	5,270	5,740	6,780	5,971	—11.7	—4.1
Neshoba	5,660	5,300	5,290	5,901	—4.1	—11.5
Newton	6,920	6,260	5,340	6,567	5.4	—16.4
Noxubee	12,410	12,460	11,730	12,102	2.5	—18.8
Oktibbeha	12,520	11,850	11,270	11,448	9.4	—2.6
Panola	17,090	18,010	16,570	16,226	5.3	—7.2
Pearl River	5,430	5,830	5,010	5,190	4.6	15.5
Perry	2,710	2,040	2,010	2,412	12.4	9.1
Pike	15,000	15,650	15,610	15,408	—2.6	—1.9
Pontotoc	3,460	3,560	3,190	3,286	5.3	—13.9

Table 7. Continued

Mississippi Counties	Population 1963	1962	1961	1960**	Percent Change 60-63	50-60**
Prentiss	2,450	2,320	2,440	2,186	12.1	—6.3
Quitman	13,870	12,780	13,640	13,304	4.3	—15.3
Rankin	14,510	14,900	12,860	12,818	13.2	—6.2
Scott	8,410	7,970	7,050	8,137	3.4	—13.2
Sharkey	7,570	7,760	7,960	7,491	1.1	—18.5
Simpson	7,080	7,690	7,760	7,200	—1.7	—1.0
Smith	3,800	3,370	3,250	3,247	17.0	—4.2
Stone	1,760	1,840	1,700	1,711	2.9	25.3
Sunflower	33,370	33,230	31,510	31,020	7.6	—18.7
Tallahatchie	15,990	15,810	15,820	15,501	3.2	—20.1
Tate	12,190	10,870	10,150	10,442	16.7	0.7
Tippah	3,220	2,660	2,920	2,756	16.8	—18.8
Tishomingo	710	770	730	679	4.6	—15.8
Tunica	13,440	13,590	12,840	13,321	0.9	—24.8
Union	3.290	2,980	2,940	3,312	—0.7	—8.9
Walthall	6,030	5,760	6,020	6,100	—1.1	—14.9
Warren	19,720	20,590	19,630	19,759		—1.7
Washington	43,470	41,360	44,830	43,399		—7.8
Wayne	6,230	5,680	5,530	5,809	7.2	—6.6
Webster	2,850	3,010	3,200	2,642	7.9	—1.9
Wilkinson	8,930	9,090	9,500	9,428	—5.3	—3.4
Winston	8,880	7,900	8,170	8,393	5.8	—9.7
Yalobusha	5,650	5,440	5,510	5,540	2.0	—16.8
Yazoo	19,700	20,700	18,150	18,791	4.8	—14.9

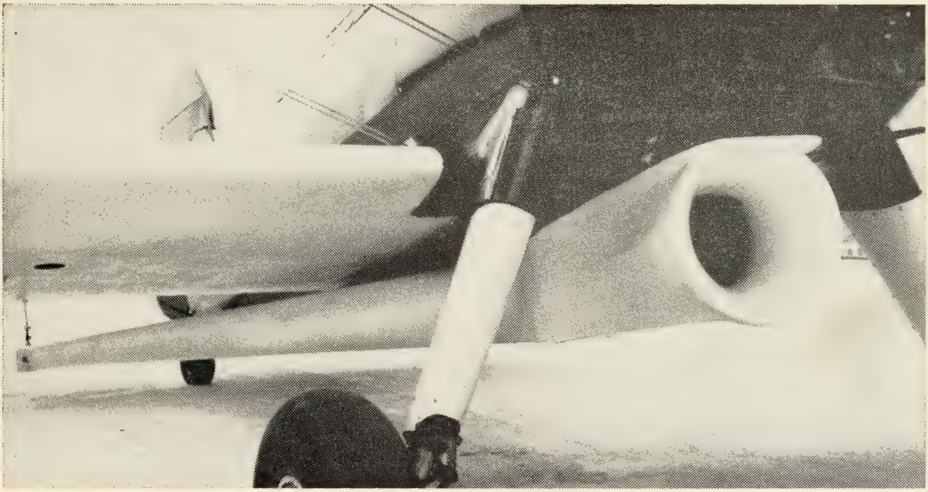
*Midyear.

**Bureau of the Census enumeration.

Estimates are rounded.

BULLETIN 694 JULY 1964

New Aerial Application System



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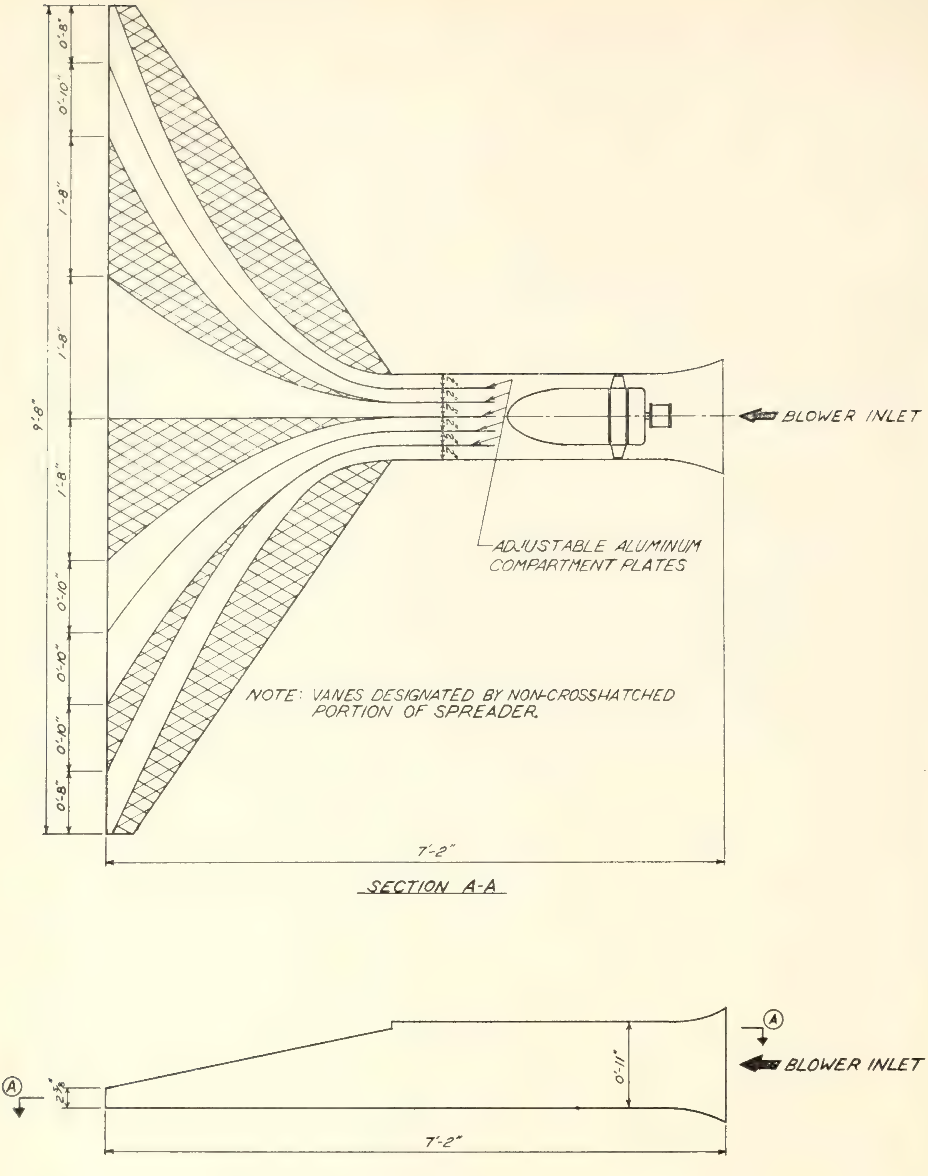
0'-8"
0'-10"
1'-8"
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9'-8"
1'-8"
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0'-10"
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BLOWER INLET
ADJUSTABLE ALUMINUM COMPARTMENT PLATES
7'-2"
SECTION A-A
A
0'-11"
BLOWER INLET
A
2 5/8"
7'-2"

NOTE: VANES DESIGNATED BY NON-CROSSHATCHED PORTION OF SPREADER.

Figure 2. Schematic of distributor.

ON THE COVER:

Fig. 1. Planes apply much of the insecticides and fertilizers farmers use but the system of distributing dusts and granules has changed little since aerial application began 40 years ago. The forward motion of the plane forces air into the funnel shaped inlet, driving the chemical out at the rear. Agricultural engineers at Mississippi State University have now added a power driven blower to the system. The result is a wider swath, better control of the dust, and a reduced power requirement for the plane.

NEW AERIAL APPLICATION SYSTEM

By

FRED L. SHUMAN, JR., WILLIAM R. FOX, and JAMES H. ANDERSON

It has been shown that swath width is one of the predominant factors which controls the cost of applying chemicals and materials by aerial methods. Most of the equipment in use today for applying dust and granules is similar to that used 40 years ago when aerial application was begun. The most frequently used system is the venturi or ram-air which produces swaths 30 to 45 feet wide. This system consumes approximately 40 horsepower at normal flight speeds and is only 6 percent efficient under optimum conditions.

In an attempt to increase the efficiency of aerial application, the Agricultural Engineering Department of Mississippi State University has designed and constructed an engine-driven system which requires less power to operate, permits a greater degree of control over the ejected materials, and increases the swath width.

This new system, which has been incorporated in a 220-horsepower Stearman aircraft, was evaluated jointly by the Agricultural Engineering Department and the Aerophysics Department at Mississippi State. A complete flight analysis was condulted to determine the drag of the system, the power required to operate the blower, and the portions of the system that may require additional research and modification.

This report covers the first phase of the evaluation program which includes the method employed to measure the chemical distribution, the effect of operational factors on swath distribution, and a discussion of the work potential of the positive-energy distributor system.

Design and Operation Principles

The general appearance of the positive-energy system (Figure 1) is similar to that of the venturi system. Both function on the principle of increasing the lateral velocity of the particles in order to get maximum swath width and some control over particle placement. The major difference is the point at which the maximum velocity occurs in the distributor system. In the venturi the maximum velocity is usually in the throat of the venturi where the material is injected into the ram-air. From this point on the velocity is decreasing. The positive-energy system overcomes this difficulty by utilizing an engine-driven blower to supply the required flow of air.

The spreader (Figure 2) was designed so that the maximum air velocity would occur at the outlet. Therefore, the particles which are subjected to an increasing force are ejected at a greater lateral velocity, and the adverse effects of the propeller slip-stream air are reduced.

A 10-inch axivane blower (Figure 3) supplies the air for the spreader system and is belt-driven from the generator drive gear on the engine. While the capacity of this blower was less than that desired, it was the only one produced commercially that would meet other design requirements.

A sliding gate arrangement was used as a metering device. One side of the gate has 2-inch triangular serrations to permit more positive control over materials at low flow rates. Adjustable aluminum plates were installed beneath the hopper gate and behind the blower as additional metering devices. The trailing edge of each plate was attached to the forward edge of the speader vane so that material dropped into a given compartment must be ejected from a certain position on the spreader. The bottom of the

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*Acknowledgement:
Part of the work of this study was cooperative with the Agricultural Aviation Section of Aerophysics Department, M.S.U. Special appreciation is expressed to Michael R. Smith and Sean C. Roberts.

spreader can be removed beneath these plates to permit quick adjustments and inspection.

A second blower ($1\frac{1}{2}$ horsepower centrifugal) was mounted so that its drive mechanism would supply air to the agitator pads in the hopper in addition to acting as an idler for maintaining the proper tensions in the main blower drive belt. The air pads were installed in the lower portion of the hopper dropbox and on the sides of the hopper to keep materials from bridging or choking the hopper outlet.

The most unique feature of the positive-energy system is probably the method by which it attains greater swath widths. With the venturi system, swath width is controlled to great extent by the altitude at which the aircraft operates. However, as the altitude is increased, the danger of chemical drift is also increased. With the positive-energy system, the material is ejected laterally into the wing-tip vortices in order to obtain greater swath widths at lower altitudes. (Figure 4) Also, the chance of chemical drift is greatly reduced since the material is released from a low altitude and entrained in the outer portion of the vortex flow.

Tests and Measurements of Swath Characteristics

To evaluate the system, it was desirable to measure the lateral distribution of the material in the swath and to determine what effect hopper load, altitude, flight speed, and mass rate of flow of the material would have on these characteristics.

The material used in this test was an inert calcium carbonate dust, which is the diluent for many chemical dust formulations. The first series of tests were designed to calibrate the metering device and to determine how the metering compartments should be arranged to produce a uniform chemical distribution in the swath.

During calibration, the compartment plates in the speader were set 2-inches apart. During the runs, the right side of the spreader deposited more material than the left side. Photographs made at various engine speeds revealed that there was a reversal of the flow on the inlet and that the flow was assymmetrical. From photographs it could be seen that due to the angular flow behind the propeller a large region of separated flow occurred at the lip of the inlet producing non-uniform flow in the axial blower. In addition the flow separated off the lip of the inlet and produced poor flow about the spreader.

To determine exactly what effect the propeller slip stream was producing on the flow inside the spreader, a small integrating pressure rake was constructed which could be installed in the bottom of the hopper in order to determine the average velocity in each compartment. These data revealed that for uniform spacing of the compartment plates there was a great variation in average velocity, but that this variation was not affected by flight speed. There was less than a 5-percent variation in average velocity in any compartment when the blower was run at full speed on the ground and when it was flown at 80 miles per hour. This means that the total head behind the propeller does not vary much with forward velocity, indicating that total head under the hopper gate is primarily a function of blower capacity. Thus, by increasing blower capacity, greater lateral velocity could be obtained. Using the integrating rake, the plates were adjusted until a uniform velocity distribution was achieved in the compartments.

The plot of actual chemical density against swath dimension is a conventional method of describing the effectiveness of an agricultural aircraft. The uniformity of chemical distribution in the swath, the shape of the distribution curve, the total swath width and effective swath width are the features of prime interest.

Many methods have been devised for measuring the density of the chemical in the swath, in this case, it was desirable

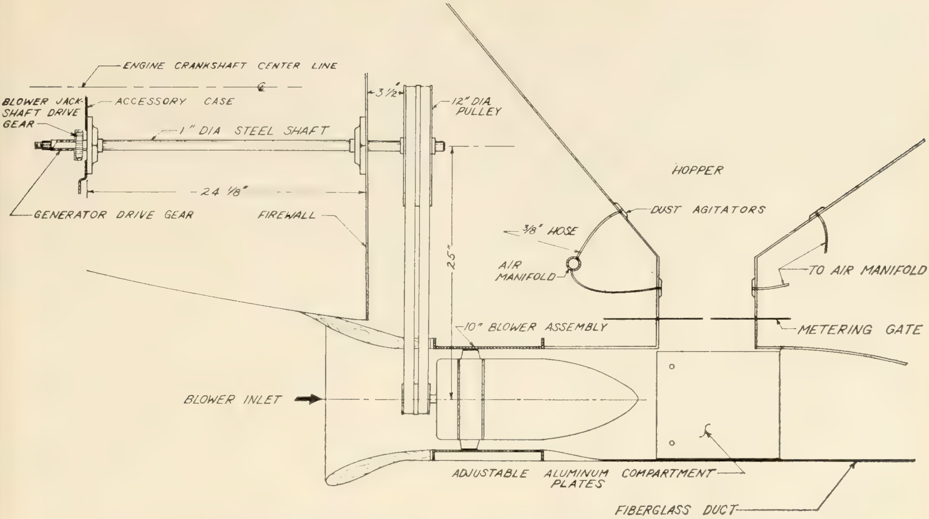
ENGINE CRANKSHAFT CENTER LINE
℄
BLOWER JACK-SHAFT DRIVE GEAR
ACCESSORY CASE
3½"
12" DIA. PULLEY
1" DIA STEEL SHAFT
24 ⅛"
GENERATOR DRIVE GEAR
FIREWALL
HOPPER
DUST AGITATORS
3/8" HOSE
AIR MANIFOLD
25"
TO AIR MANIFOLD
10" BLOWER ASSEMBLY
METERING GATE
BLOWER INLET
ADJUSTABLE ALUMINUM PLATES
COMPARTMENT
FIBERGLASS DUCT

Figure 3. Schematic of blower drive system and metering device.

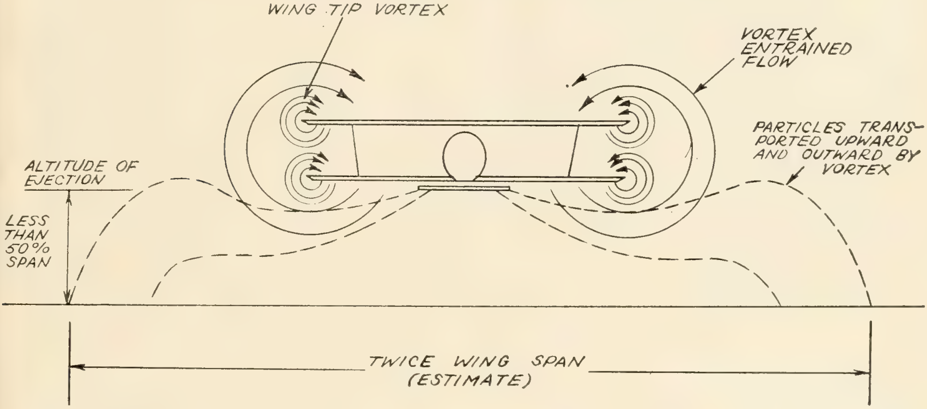
WING TIP VORTEX
VORTEX ENTRAINED FLOW
PARTICLES TRANSPORTED UPWARD AND OUTWARD BY VORTEX
ALTITUDE OF EJECTION
LESS THAN 50% SPAN
TWICE WING SPAN (ESTIMATE)

Figure 4. Method of entraining materials in wing-tip vortices to achieve greater swath widths.

to use a method which was accurate but which would not be so time consuming as to limit the number of test runs that could be measured on a particular day.

The technique of measuring chemical deposits using fluorescent tracers, which was previously used by personnel of the Mississippi Delta Branch Experiment Station, was modified for this study. The same optical equipment was used to measure the density of the calcium carbonate dust in the swath. Rhodamine-B dye, a fluorescent material, was ground into calcium carbonate dust at the rate of 1 lb. of Rhodamine-B to 750 lbs. of dust. By dissolving the dust-dye mixture in methanol, it was possible to form a true solution whose fluorescent concentration was related to the density of calcium carbonate in the sample. From a calibration curve it was possible to determine the quantity of calcium carbonate dust in the sample.

Collection of dust samples was made in 9-inch diameter aluminum pans laid out perpendicularly to the line of flight.

These pans were initally spaced 5 feet apart for a distance of 150 feet. However, after several runs the interval between the pans was increased to 10 feet for a distance of 200 feet.

All runs with the exception of crosswind tests were run when surface wind velocity was less than 3 miles per hour. If there was a surface wind, the sampling station was set up perpendicular to the wind direction. While contradictory to general field practice, this feature was most appropriate for evaluating the distributor system.

Results and Discussion:

General: The positive-energy distributor system and the principle of entraining materials in the vortex flow field appear to offer extremely large increases in application efficiency, aircraft work rates, and control of chemical placement. Swath widths 2½ times that of the standard venturi systems were attained during the tests and swaths 80 to 100 feet wide may be expected in most field applications. The sequence of photographs in Figure 5 shows the progressive entrainment in transportation of the dust material by the wing-tip vortices.

Effects of hopper load and hopper setting: Calibration of the metering system revealed that the mass rate of flow of material was greatly affected by the quantity of material that remained in the hopper at any instant. While it was realized that this metering system was not ideal, it was used for several reasons: (1) it was similar to that used in many current systems. (2) By incorporating it in the positive-energy system, tests would reveal its capabilities and limitations. (3) Development of a positive-feed metering device is a separate problem within itself.

By holding the hopper load, speed, and altitude constant and varying the hopper gate opening, a reasonable relationship was obtained between mass rate of flow and hopper opening. To minimize the adverse effects of hopper load, each pass was started with a 200 lb. load at a given distance from the sampling station and run approximately the same length. Under similar flight conditions, this technique worked very well and duplication of tests revealed little variation in test results.

Effect of altitude: With the standard venturi system an increase in operating altitude results in a moderate increase in swath width up to some height where lateral distribution is limited by the maximum velocity at which the material is projected from the distributor. However, the positive-energy system depends upon its ejection velocity, primarily, to transport the material particles into the vortex flow where the particles are spread laterally by a combination of their initial momentum and the action of the wing-tip vortex.

When the wing of the aircraft is in close proximity to the ground, the lateral velocity vortex movement is maximum. As the distance between the wing and the ground is increased, the lateral velocity is reduced until at the height of approximately two wing spans there is hardly any lateral movement of the vortex cores.

Since both principles are incorporated in the positive-energy system, the optimum height of operation for maximum swath width would be somewhat less than that of the venturi system. The optimum ejection height for maximum swath width is approximately 15 feet for the system tested. When operated at altitudes of less than 10 feet, there was a pronounced tendency for the vortex entrained materials to rebound from the ground. Due to ground-effect force, low ejection resulted in poor distribution patterns and a decrease in the amount of dust deposited. Slightly greater swath widths could be attained by flying at 20 feet. However, this would be practical only with calm conditions and where penetration of the chemical within the plant foliage was not required. When altitude was increased above 20 feet, swath width was reduced and control of chemical placement became a serious problem

When wind velocity was great enough to stop application at the 15-foot altitude, it was not feasible to operate at much lower altitudes because of chemical drift caused by the rebound of the wing-tip vortices from the ground and a sizable reduction in swath width.

Effect of speed: Probably the most surprising result of all was the effect of flight speed on chemical distribution and swath characteristics,. Eighty miles per hour was selected as the standard speed for all tests because the aircraft handled well at this speed. It allowed a greater margin of safety than lower speeds and it was comparable to general application speeds.

Tests of the effect of flight speed on the blower output revealed that air quantity flow varied less than 5-percent between 0 and 80 miles per hour and that between speeds of 60 and 90 miles per hour variations in quantity flow were negligible. Since the total weight of the aircraft was approximately the same for all tests, it was proposed that any appreciable changes in swath characteristics could be attributed to changes in vortex strength which is a function of flight speed. However, tests showed that 80 miles per hour was the poorest speed of operation when performance was measured in total amount of chemical deposited regardless of altitude. Likewise, if a given rate per acre was selected as a standard and all the swath lengths falling below the level were summed, 80 miles per hour produced the narrowest swath.

Effect of swath width: After numerous data for individual passes had been collected and analyzed, an attempt was made to simulate a field application by making three passes over the sampling station and measuring the chemical distribution. Tests were conducted using 80, 100 and 120 feet swath intervals. Although results were not uniform, effective swaths up to 100 feet appear attainable under most operating conditions, and swaths greater than 120 feet were attained in numerous tests.

While the uniformity of the swath is not as good as might be desired, it must be remembered that the system tested was constructed to determine the feasibility of entraining materials in the wing-tip vortex to increase the effective swath width. Increasing the uniformity of the distribution is primarily a problem of metering the proper quantity of material into the proper section of the spreader and regulating other factors such as speed, altitude, swath width and blower capacity. Results of further modifications and research will be made available in later reports.

Summary

The positive-energy-distributor principle was found to be a revolutionary and unique concept of aerial distribution of solid material. The system functioned as designed and offers great potential for increasing utility and economy of aerial application of fixed-wing aircraft.

The lack of a positive-feed mechanism to meter the materials was one of the most serious deficiencies of the overall system. Additional research on a positive-feed mechanism and more efficient methods of entraining and transporting materials will be required to optimize performance of the system.

For general application work, a flight speed of 90 miles per hour and an ejection altitude of 15 feet produced the widest swath and gave best control over the ejected material. It was not feasible to vary altitude in an attempt to minimize the effects of wind or to alter application rates. For some yet undetermined reason, the flight speed of 80 miles per hour produced poorest uniformity of distribution and the narrowest swaths.

Swaths up to 120 feet wide are attainable, but 80 to 100 feet swaths would probably be most practical for field application. The uniformity of the chemical distribution can be altered appreciably by proper metering and the development of flying techniques.

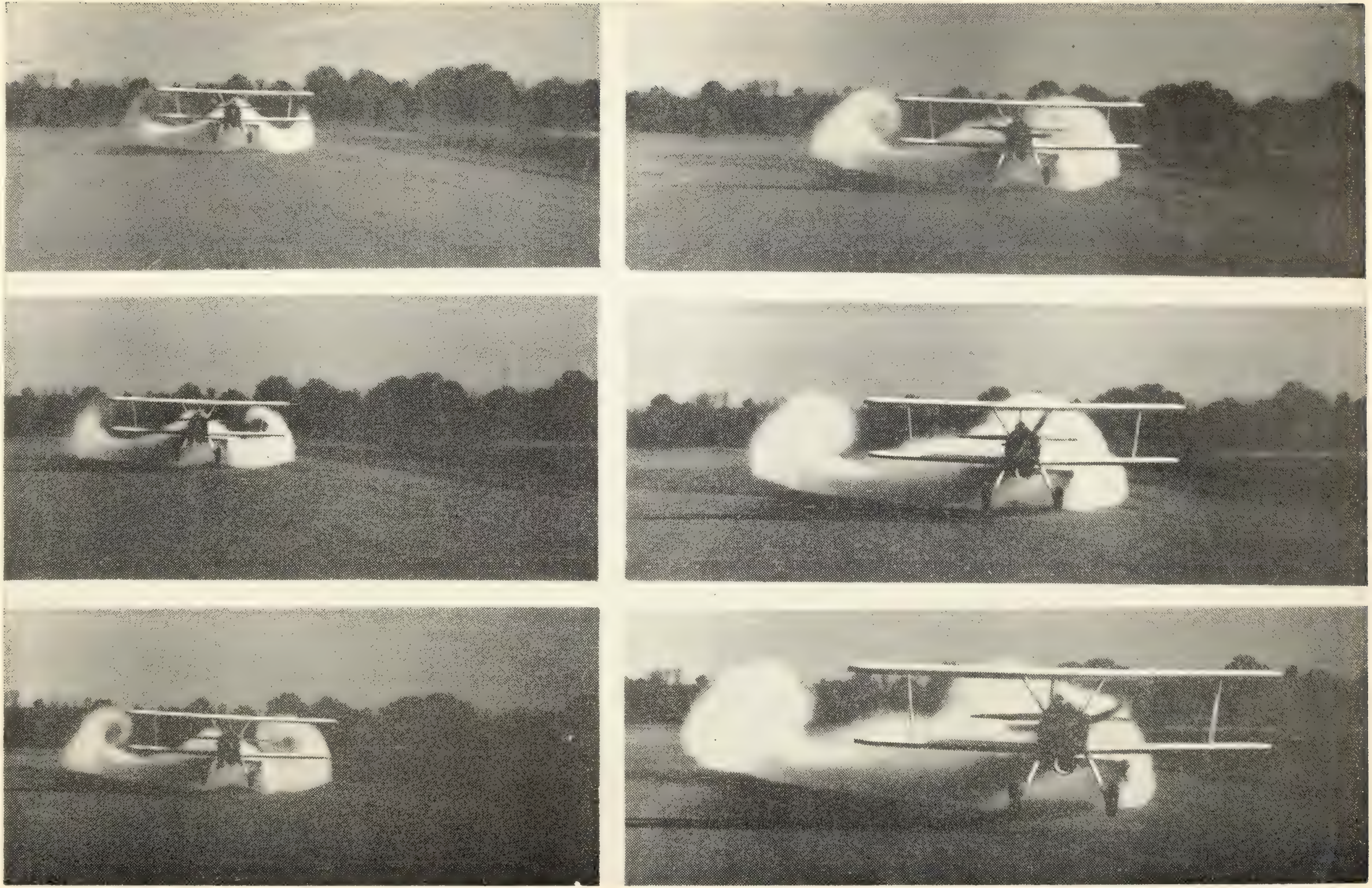

Figure 5. This sequence of photos shows how the new distributor system is able to obtain a wider swath (100-120 feet). Note how the dust particles are transported upward and outward by the wing-tip vortices.

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Effect of Harvesting Conditions On Cotton Quality In The Yazoo-Mississippi Delta

by

MORRIS M. LINDSEY

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AUG 9 1967
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AGRICULTURAL EXPERIMENT STATION
HENRY LEVECK, Director
STATE COLLEGE MISSISSIPPI

PREFACE

The rapid technological changes that have affected the cotton industry in the last two decades have made it necessary for the cotton producer to constantly revise his production system. Many of these production changes and improvements have been associated with harvesting and ginning practices. In some instances, these changes have not been an orderly evolution; certain technologies occurred haphazardly within the system.

As more and more of the Delta cotton crop is harvested by mechanical cotton-pickers, farmers are concerned with the quality of the cotton picked by this method. This report is an evaluation of the effect of selected factors on cotton quality based on the method of harvesting the Delta crop. Another publication now being prepared will report the economics of all methods of harvesting cotton in the Delta.

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ACKNOWLEDGEMENTS

Numerous individuals and agencies are acknowledged for their cooperation and help during this study. Farmers and gin operators who furnished the basic data for this report are recognized for their aid and assistance. Special thanks are due Dr. T. E. Tramel, Department of Agricultural Economics, Mississippi State University, for his invaluable help in programming the data and in the interpretation of computer results.

Much appreciation and special thanks are due Arthur M. Heagler, Agricultural Economist, Farm Production Economics Division, ERS, USDA, for his work in coding of data and his aid in preparation of final tables for this report.

THE EFFECT OF HARVESTING CONDITIONS ON COTTON QUALITY IN THE YAZOO-MISSISSIPPI DELTA

By MORRIS M. LINDSEY[1]

The quantity of cotton harvested by machine has exceeded hand picking in the Yazoo-Mississippi Delta[2] for several seasons, and the trend continues toward increasing use of mechanical pickers. In a recent publication,[3] the Bureau of Employment Security reported that 57 percent of the 1961 crop in Mississippi was picked mechanically. This figure includes hill counties where proportionately less cotton is picked by machine because of such factors as smaller acreages, smaller fields, and uneven terrain. It is estimated that nearly 75 percent of the 1962 Delta crop was picked mechanically.

Most farmers have turned to mechanical harvesting because they believe this method is more economical. Others have changed because of the uncertainty of an adequate supply of hand labor in some Delta areas. If unlimited labor were still available at current wage rates, some farmers would prefer to use hand pickers, many would continue to use machines only, and others would use a combination of the two methods, This report deals with an evaluation of the two methods of harvesting cotton in the Delta based on ginning results by area, season, days of rainfall, and inches of rainfall.

The shift from hand picking to mechanical picking has forced Delta gin operators to make costly adjustments in the complex equipment necessary to properly gin machine-picked cotton. The speedup in harvest associated with the use of machines has also caused gins to become serious bottlenecks during the harvesting season in recent years. For these and other reasons a new look at the effect on cotton quality may prove revealing.

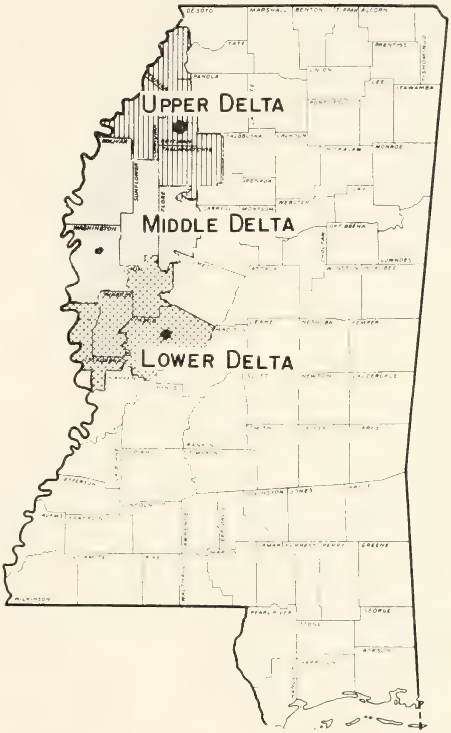

Figure 1. Location of gins from which data was secured, Yazoo-Mississippi Delta.

Method of Study

Three gins were selected for the study; one each in the Lower Delta, Middle Delta, and Upper Delta areas, Figure 1. To secure valid comparisons, each gin selected was required to have entry scales, seed scales, comparable ginning equipment, gin about the same volume, and gin basically the same varieties. The resulting sample totaled 10,096 bales 5,364 bales of hand-picked cotton and 4,732 bales of machine-picked cotton.

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[1] Agricultural Economist, Farm Production Economics Division, Economic Research Service, U. S. Department of Agriculture, cooperating with the Mississippi Agricultural Experiment Station, stationed at the Delta Branch of the Mississippi Agricultural Station, Stoneville, Miss.

[2] For the remainder of this report the Yazoo-Mississippi Delta will be referred to as "the Delta."

[3] "Cotton Harvest Mechanization — Effect on Seasonal Hired Labor," U. S. Department of Labor, Bureau of Employment Security, BES No. 209, June 1962.

The 1960 ginning season was selected because the crop was considered good (table 1) with picking weather and harvesting conditions only fair. This combination of factors was considered a general representation of Delta growing conditions. Most of the cotton matured fairly early in the 1960 season and picking started generally during the last 2 weeks of August. The ginning results from this crop and selected measures of quality are treated in this report. Data on each of the 10,096 bales were tabulated as to area, picking season, method of harvest, seed cotton weight, bale weight, seed weight, grade index, staple index, rainfall occurrence during harvest, rainfall intensity during harvest, percentage of gin turnout, percentage of seed turnout, and percentage of waste. The data were then summarized and analyzed on an electronic computer.

Lower Delta

For the purpose of this report, the Lower Delta consists of Yazoo, Humphreys, Sharkey, and Issaquena Counties. The representative gin is located in the Delta part of Yazoo County. The growing season for the area during 1960 was not considered unusual. As the cotton crop began to open, heavy rains occurred, starting the first week in August and continuing for the remainder of the month.

To facilitate analysis the ginning season was divided into 2-week intervals. These 2-week intervals were subsequently grouped into early, middle, and late ginning seasons. These seasons were determined as follows: the middle ginning season was composed of the 6 consecutive weeks of highest ginning concentration; the early ginning season consisted of any cotton ginned previous to the middle season; and the late season consisting of all cotton ginned after the middle season.

Early Ginning Season: Only four hand-picked bales of cotton were ginned during the 2-week period of August 15 through 27 because of rain during 6 of the 14 days with a measured rainfall of 4.13 inches (table 2). Showers continued during the next 2-week period, August 29 through September 10, with 5 days of measurable rainfall amounting to 0.6 inches. Hand picking increased to 291 bales, but the ground was still too wet for mechanical picker operation. This concluded the early ginning season for this gin with 295 bales—all hand picked.

Middle Ginning Season: The three 2-week periods that comprised the 6-week period of consecutive heaviest ginning concentration, the middle ginning season, started September 12 and ended October 22. Machine picking started abruptly during this period (table 2) even though farmers stated that they were reluctant to do so because fields were still wet and the cotton damp and heavy. Most farmers started machine picking under these unfavorable conditions because they remembered the 1957-58 picking season, when heavy rainfall persisted for long periods.

During the first 2 weeks of the middle season, September 12 through 24, which was characterized by showers on 5 of the 14 days amounting to a total of 0.55 inches of rainfall, 591 hand-picked bales were ginned. This cotton graded an average of 99.5[4] or just under Middling

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[4] See table 3 for index numbers that correspond to the standard grades used in cotton classing.

Table 1. — Acreage, yield, and production of cotton per harvested acre, Yazoo-Mississippi Delta, 1960

Area and county	Acres harvested	Percentage of total	Lint per acre
	Acres	Percent	Pounds
Lower Delta			
Yazoo	42,000	4.97	474
Humhreys	51,400	6.09	540
Issaquena	12,200	1.44	573
Sharkey	30,700	3.64	597
Total	136,300	16.14	535
Middle Delta			
Washington	93,500	11.07	491
Bolivar	125,400	14.85	517
Sunflower	131,300	15.54	474
Leflore	83,100	9.84	565
Total	433,300	51.30	508
Upper Delta			
Tallahatchie	64,000	7.58	512
Quitman	62,800	7.44	537
Coahoma	98,000	11.60	578
Tunica	50,100	5.93	518
Total	274,900	32.55	542
Total Delta	844,500	[1]55.56	523

[1] Percentage of total State harvested acreage.

with an average staple of 34.3[5] or just over 1 1/16 inches. Three hundred forty-eight bales of cotton, machine picked under unfavorable conditions, were ginned during this same 2-week period. Machine-picked cotton graded 92.4 or more than one full grade below the hand-picked cotton during the same period. Staple length for machine-picked cotton was 34.1 or about 1 1/16 inches which was almost identical to hand-picked cotton. It took an average of 1,507 pounds of hand-picked seed cotton to produce 500 pounds of lint during this 2-week period, compared to 1,572 pounds of machine-picked cotton per 500-pound bale. Gin turnout was 33.3 percent for hand-picked cotton and 31.9 for cotton picked by machine. Hand-picked cotton exhibited 7.69 percent waste (moisture, trash, and foreign matter) compared to 11.90 percent for machine-picked cotton.

During the 42-day middle ginning season rain occurred on 13 days for a total rainfall of 2.18 inches. In an area where 7 of every 10 bales are normally picked by machine, only 1,061 bales were machine picked compared to 1,478 hand-picked bales during the middle ginning season (table 4). This reflects the poor machine picking conditions due to unfavorable weather. Gin turnout favored hand-picked cotton by 1.33 percentage points as did waste percentage by 4.01. Grade was about one full grade better for hand-picked cotton while staple length differences were almost negligible for the two methods of picking. The 1,478 hand-picked bales ginned during the middle season constituted 58.3 percent of all hand-picked cotton ginned during the 1960 season for the Lower Delta gin. In contrast, the 1,061 machine-picked bales for the same period represented 78.8 percent of all machine-picked cotton processed at the same gin. The 2,539 bales ginned at the Lower Delta plant during the middle season accounted for 65.4 percent of all cotton ginned there.

Late Ginning Season: Unfavorable weather causing poor mechanical picking conditions forced many farmers to continue use of hand pickers during the

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[5] Staple index is based on each 32nd inch of staple having a value of one; i.e. a value of 32.0 would indicate a staple length of 1 inch.

Table 2. Relationship between selected measures of cotton quality and harvesting conditions, by two-week intervals, Lower Mississippi Delta, 1960

2-week period	Bales ginned	Seed cotton weight	Bale weight	Seeds weight	Grade Index	Staple Index	Days of rain	Amount rain	Gin turnout	Seed turnout	Waste
	Number	Pounds	Pounds	Pounds	Index	Index	Number	Inches	Percent	Percent	Percent
					Hand Picked						
Aug. 15-17	4	1,548	509	950	92.5	33.5	6	4.13	32.9	61.4	5.70
Aug. 29-Sept. 10	291	1,631	526	966	98.3	34.3	5	.60	32.3	59.2	8.50
Sept. 12-24	591	1,567	520	925	99.5	34.3	5	.55	33.3	59.0	7.69
Sept. 26-Oct. 8	432	1,587	501	945	98.7	34.4	7	1.53	31.6	59.6	8.81
Oct. 10-22	455	1,607	487	923	96.2	34.0	1	.10	30.4	57.5	12.06
Oct. 24-Nov. 5	341	1,651	491	907	94.1	33.5	3	.46	29.9	54.9	15.15
Nov. 7-19	204	1,728	491	906	92.3	33.6	3	1.45	28.7	52.7	18.59
Nov. 21-Dec. 3	142	1,746	483	890	90.5	33.2	3	1.88	28.0	51.5	20.46
Dec. 5-17	31	1,800	509	945	89.7	33.2	7	2.16	28.5	52.8	18.70
Dec. 19-31	42	1,966	516	1,011	85.8	32.9	8	2.72	26.6	52.3	21.15
					Machine Picked						
Aug. 15-27											
Aug. 29-Sept. 10											
Sept. 12-24	348	1,563	497	879	92.4	34.1	5	.55	31.9	56.2	11.90
Sept. 26-Oct. 8	376	1,623	488	927	92.9	34.2	7	1.53	30.2	57.0	12.84
Oct. 10-22	337	1,660	491	911	90.8	34.0	1	.10	29.6	54.9	15.47
Oct. 24-Nov. 5	203	1,719	476	897	83.9	33.2	3	.46	27.9	52.3	19.82
Nov. 7-19	67	1,805	514	953	86.0	33.5	3	1.45	28.5	52.8	18.72
Nov. 21-Dec. 3	8	1,531	438	793	83.6	33.1	3	1.88	28.5	51.6	19.84
Dec. 5-17	8	1,822	514	946	80.7	33.6	7	2.16	28.2	52.2	19.60
Dec. 19-31											
					Total Picked						
Aug. 15-27	4	1,547	509	950	92.5	33.5	6	4.13	32.9	61.4	5.70
Aug. 29-Sept. 10	291	1,631	526	966	98.3	34.3	5	.60	32.3	59.2	8.50
Sept. 12-24	939	1,565	511	908	96.9	34.2	5	.55	32.8	58.0	9.25
Sept. 26-Oct. 8	808	1,604	495	936	96.0	34.3	7	1.53	30.9	58.4	10.69
Oct. 10-22	792	1,630	489	918	93.9	34.0	1	.10	30.1	56.4	13.51
Oct. 24-Nov. 5	544	1,676	486	903	90.3	33.4	3	.46	29.1	54.0	16.89
Nov. 7-19	271	1,747	497	918	90.8	33.6	3	1.45	28.6	53.0	18.63
Nov. 21-Dec. 3	150	1,735	481	885	90.1	33.2	3	1.88	28.1	51.5	20.43
Dec. 5-17	39	1,804	510	945	87.9	33.3	7	2.16	28.4	52.7	18.89
Dec. 19-31	42	1,966	516	1,011	85.8	32.9	8	2.72	26.6	52.3	21.15

Table 3.—Numerical values assigned to cotton grades for purpose of computing grade index[1]

Grades	White	Light Spotted	Spotted	Tinged	Yellow Stained	Light Gray	Gray
SGM	106	----	----	----	----	----	----
GM	105	103	101	94	86	99	93
SM	104	102	99	91	81	98	91
MID Plus	102	----	----	----	----	----	----
MID	100	97	93	82	73	92	84
SLM Plus	97	----	----	----	----	----	----
SLM	94	89	83	75	----	85	75
LM Plus	90	----	----	----	----	----	----
LM	85	80	75	68	----	----	----
SGO Plus	81	----	----	----	----	----	----
SGO	76	----	----	----	----	----	----
GO Plus	73	----	----	----	----	----	----
GO	70	----	----	----	----	----	----
			Below Grade 60				

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[1] Data furnished by United States Department of Agriculture, Agricultural Marketing Service, Cotton Division, November 1959.

Table 4.—Relationships between selected measures of cotton quality and harvesting conditions, by ginning season, lower Mississippi Delta, 1960

Season	Bales ginned	Seed cotton weight	Bale weight	Seed weight	Grade index	Staple index	Days of rain	Amount rain	Gin turnout	Seed turnout	Waste
					Hand Picked						
Early	295	1,630	525	966	98.20	34.25	11	4.73	32.28	59.26	8.46
Middle	1,478	1,585	504	930	98.24	34.24	22	5.97	31.91	58.72	9.36
Late	760	1,713	492	911	92.31	33.42	15	4.88	28.97	53.49	17.54
Total	2,533	1,629	503	929	96.46	34.00	48	15.58	31.07	57.21	11.71
					Machine Picked						
Early											
Middle	1,061	1,615	492	905	92.04	34.08	22	5.97	30.58	56.05	13.37
Late	286	1,737	485	908	84.31	33.30	7	2.16	28.05	52.39	19.56
Total	1,347	1,641	490	906	90.40	33.92	29	8.13	30.05	55.27	14.68
					Total Picked						
Early	295	1,630	525	966	98.20	34.25	11	4.73	32.28	59.26	8.46
Middle	2,539	1,598	499	920	95.65	34.17	22	5.97	31.36	57.60	11.04
Late	1,046	1,719	490	910	90.13	33.39	15	4.88	28.72	53.19	18.09
Total	3,880	1,633	499	921	94.36	33.97	48	15.58	30.72	56.54	12.74

late ginning season at the Lower Delta gin. Only 286 bales of machine-picked cotton were ginned during the late season with 203 of these falling in the first 2 weeks after the middle ginning season. Only 16 bales of machine-picked cotton were ginned after November 19 as compared to 215 hand-picked bales ginned for the same period. A total of 760 bales of hand-picked cotton was ginned at the Lower Delta gin during the late season. Grade index favored hand-picked cotton during the late ginning season by more than a full grade, 92.31 to 84.31 index points while staple length was again almost identical for the two picking methods. Waste percentage and gin turnout percentage still favored hand picking in the late ginning season, but the margin was not as great as for the early and middle ginning seasons.

Entire Season: Based on the entire ginning season for the Lower Delta gin, cotton picked by hand exhibited better quality after ginning than did machine-picked cotton. Handpicked cotton averaged a full grade better, had slightly longer staple, exhibited better gin turnout and seed turnout, and had less waste than machine-picked cotton. Because of heavy fall rains more cotton was picked by hand than by machine, 2,533 bales by hand and 1,347 bales by machine. This condition would be practically reversed in a year when picking conditions would allow a free choice of the method to be used in harvesting

Middle Delta

The Middle Delta is comprised of Washington, Bolivar, Sunflower, and Leflore Counties. The sample gin is located in the northeast corner of Washington County, near the center of the area. The Middle Delta had a better than average cotton crop in 1960 even though this area was plagued by heavy August rains occurring as the crop reached maturity and began to open. Cotton land served by the Middle Delta gin was lighter and better drained than the cropland served by the Lower Delta gin. For this reason the use of machines started earlier in the Middle Delta.

Early Ginning Season: Hand picking started about August 15. During the 2-week period, August 15 through 27, 50 bales were ginned even though 1.98 inches of rain fell during 6 of the 14 days. There was no machine picking during this period. From August 29 through September 10 both hand- and machine-picked cotton were ginned. However, the rains continued on 5 of the 14 days and totaled 1.97 inches. Hand-picked cotton exceeded machine-picked cotton by 234 bales to 193 bales. Grade for machine-picked cotton was slightly less than hand-picked cotton, but staple was almost identical (table 5).

Middle Ginning Season: Rains continued to hamper the harvest during the first 2 weeks of the middle ginning season as 2.14 inches fell on 6 of the 14 days. Machine-picked bales outnumbered hand-picked bales during each of the three 2-week periods that comprised the middle ginning season, September 12 through October 22. The rains abated during the last month of the middle ginning season with 7 of the 28 days registering showers that measured 0.78 inches. Machine-picked cotton almost doubled that picked by hand—1,217 bales to 664 bales (table 6).

Grade for hand-picked cotton was about one-half grade better than the machine-picked cotton with very little difference evidenced in staple length between the two methods. However, gin turnout, seed turnout, and waste percentages all favored machine-picked cotton during the middle ginning season. This likely was caused by the higher moisture content of the seed cotton picked by hand. Hand pickers

Table 5.—Relationships between selected measures of cotton quality and harvesting conditions, by 2-week intervals, Middle Mississippi Delta, 1960

2-week period	Bales ginned	Seed cotton weight	Bale weight	Seed weight	Grade Index	Staple index	Days of rain	Amount rain	Gin turnout	Seed turnout	Waste
	Number	Pounds	Pounds	Pounds	Index	index	Number	Inches	Percent	Percent	Percent
					Hand Picked						
Aug. 15-27	50	1,617	500	885	97.9	33.7	6	1.98	31.0	54.8	14.27
Aug. 29-Sept. 10	234	1,604	534	878	98.9	33.5	5	1.97	33.4	54.8	11.84
Sept. 12-24	117	1,552	524	844	99.0	33.6	6	2.14	33.8	54.5	11.73
Sept. 26-Oct. 8	272	1,562	510	814	96.9	33.4	3	.03	32.7	52.1	15.16
Oct. 10-22	215	1,567	510	791	96.6	32.8	4	.77	32.6	50.5	16.90
Oct. 24-Nov. 5	93	1,640	493	790	93.1	32.2	4	1.99	30.2	48.2	21.60
Nov. 7-19	85	1,664	486	783	90.6	32.4	3	1.80	29.4	47.3	23.38
Nov. 21-Dec. 3	14	1,756	512	825	90.1	32.5	7	2.50	29.4	47.3	23.36
Dec. 5-17	23	1,935	498	866	88.1	31.6	8	2.99	26.0	44.9	29.03
Dec. 19-31											
					Machine Picked						
Aug. 15-27											
Aug. 29-Sept. 10	193	1,441	514	774	97.6	33.3	5	1.97	35.7	53.7	10.57
Sept. 12-24	291	1,484	508	795	95.6	33.4	6	2.14	34.3	53.6	12.15
Sept. 26-Oct. 8	525	1,520	504	809	94.1	33.2	3	.03	33.2	53.3	13.52
Oct. 10-22	401	1,545	504	813	93.9	32.9	4	.77	32.7	52.6	14.71
Oct. 24-Nov. 5	38	1,538	494	811	89.1	32.7	4	1.99	32.1	52.7	15.15
Nov. 7-19	14	1,621	494	834	86.6	32.7	3	1.80	30.5	51.5	17.99
Nov. 21-Dec. 3	5	1,536	437	717	75.4	32.2	7	2.50	28.4	46.7	28.84
Dec. 5-17											
Dec. 19-31											
					Total Picked						
Aug. 15-17	50	1,617	500	885	97.9	33.7	6	1.98	31.0	54.8	14.27
Aug. 29-Sep. 10	427	1,530	525	831	98.3	33.4	5	1.97	34.4	54.3	11.26
Sept. 12-24	408	1,509	514	814	96.9	33.5	6	2.14	34.1	53.9	11.99
Sept. 26-Oct. 8	797	1,534	506	811	95.1	33.3	3	.03	33.0	52.9	14.08
Oct. 10-22	616	1,553	506	805	94.8	32.9	4	.77	32.6	51.9	15.47
Oct. 24-Nov. 5	131	1,611	493	796	92.0	32.3	4	1.99	30.7	49.5	19.73
Nov. 7-19	99	1,658	487	790	90.9	32.4	3	1.80	29.5	47.9	22.62
Nov. 21-Dec. 3	19	1,698	493	796	86.3	32.4	7	2.50	29.1	47.1	23.75
Dec. 5-17	23	1,935	498	866	88.1	31.6	8	2.99	26.0	44.9	29.03
Dec. 19-31											

Table 6.—Relationships between selected measures of cotton quality and harvesting conditions, by ginning season, Middle Mississippi Delta, 1960

Season	Bales ginned	Seed cotton weight	Bale weight	Seed weight	Grade Index	Staple index	Days of rain	Amount rain	Gin turnout	Seed turnout	Waste
	Number	Pounds	Pounds	Pounds	Index	index	Number	Inches	Percent	Percent	Percent
						Hand Picked					
Early	284	1,606	528	879	98.70	33.51	11	3.95	32.96	54.77	12.26
Middle	664	1,561	514	815	97.35	33.23	13	2.94	32.95	52.24	14.80
Late	215	1,689	492	798	91.78	32.20	22	9.28	29.35	47.43	23.21
Total	1,163	1,596	513	827	96.65	33.11	46	16.17	32.29	51.96	15.76
						Machine Picked					
Early	193	1,441	514	774	97.64	33.33	5	1.97	35.70	53.73	10.57
Middle	1,217	1,519	505	807	94.41	33.16	13	2.94	33.28	53.14	13.58
Late	57	1,559	489	808	87.32	32.65	14	6.29	31.41	51.89	16.69
Total	1,467	1,510	506	803	94.56	33.16	32	11.20	33.52	53.17	13.31
						Total Picked					
Early	477	1,539	522	837	98.27	33.44	11	3.95	34.07	54.35	11.58
Middle	1,881	1,534	508	810	95.45	33.19	13	2.94	33.16	52.82	14.02
Late	272	1,661	491	800	90.84	32.29	22	9.28	29.78	48.37	21.85
Total	2,630	1,548	509	814	95.49	33.14	46	16.17	32.98	52.64	14.38

were able to enter fields while the seed cotton was still wet, whereas the heavier machines could not be supported until the cotton and the ground were drier.

The 1,217 bales picked by machine during the middle season accounted for 83.0 percent of all the machine-picked cotton ginned during the year. This percentage was much higher than that for the hand-picked cotton ginned during the middle season. The 664 hand-picked bales amounted to only 57.1 percent of all the hand-picked cotton ginned during the year.

Late Ginning Season: As in the Lower Delta, the mechanical picking season ended abruptly with only 19 bales being picked after November 5. A total of only 57 bales were machine picked during the late ginning season; whereas, 215 hand-picked bales were ginned during this period. As late as December 5 through 17 there were 23 hand-picked bales ginned. Grade was about two-thirds of a grade in favor of hand-picked cotton, but staple was slightly longer for machine-picked cotton. The gin turnout, seed turnout, and waste percentages were all in favor of machine-picked cotton. In addition to the reason mentioned earlier, this was probably due in part to the fact that most of the machine-picked cotton was picked early in the late season while hand scrapping continued until late in the season.

Entire Season: Based on the entire ginning season for the Middle Delta, hand-picked cotton exhibited a better grade index than machine-picked cotton. However, staple index, percentage of gin turnout, percentage of seed turnout, and percentage of waste all favored machine-picked cotton. Only 1,492 pounds of machine-picked cotton were needed to produce 500 pounds of lint as compared to 1,556 pounds of hand-picked cotton. Quality of machine-picked cotton at the Middle Delta gin compared quite favorably with that of hand-picked cotton. Total number of bales of machine-picked cotton exceeded hand-picked bales, 1,467 to 1,163.

Upper Delta

Tallahatchie, Coahoma, Quitman, and Tunica Counties make up the Upper Delta. The sample gin is located in the lower center of Quitman County. The crop in the Upper Delta was about 1 week later than that of the Middle and Lower Delta. The heavy rains of August were not as severe in this part of the Delta as in the lower part.

Early Ginning Season: Three bales of hand-picked cotton arrived at the Upper Delta gin during the 2 weeks, August 15 through 27 (table 7). During the next 2-week period, August 29 through September 10, 181 bales of hand-picked cotton and 3 bales of machine-picked cotton were ginned. During the last 2 weeks of the early ginning season more cotton picked by each method was ginned. There were 249 bales of hand-picked cotton and 198 bales of machine-picked cotton ginned September 12 through 24. This concluded the early season with 433 hand-picked bales and 201 machine-picked bales. Because of less rain and better distribution of rainfall than in the Lower and Middle Delta the quality of early season cotton in the Upper Delta was excellent (table 8). The grade index of early season hand-picked cotton averaged better than Middling White, while machine-picked cotton averaged just under Strict Low Middling Plus. Gin turnout percentages were the best found in the Delta. Staple length index differed only slightly but was in favor of hand-picked cotton. Percentage of waste was low for both methods but was lowest for hand-picked cotton.

Middle Ginning Season: Much of the late August and early September rains that affected the Lower and Middle Delta during the early ginning season missed the Upper Delta, but this changed during the middle ginning season. It rained fewer days in the Upper Delta during the middle ginning season, but rainfall was heavier. It rained 10 of the 42 days that comprised the middle ginning season for a total of 5.56 inches of rain. Between rains the cotton came to the gin in heavy concentrations, with 540 machine-picked and 194 hand-picked bales arriving during the first 2-week period of the middle ginning season—September 26 through October 8. The number of machine-picked bales exceeded hand-picked bales during the middle ginning season, 1,401 bales to 539 bales. Hand-picked cotton graded almost five index points better than machine-picked cotton (table 8) during the middle ginning season. In addition, gin turnout, seed turnout, staple index, and percentage of waste all favored the hand-picked cotton. The 1,401 machine-picked bales accounted for 73.0 percent of all machine-picked cotton at the Upper Delta gin while the 539 hand-picked bales amounted to only 32.3 percent of all the hand-picked cotton. Total cotton during the middle season amounted to 54.1 percent of all cotton ginned at the Upper Delta gin.

Late Ginning Season: Mechanical picking did not diminish as rapidly during the late ginning season in the Upper Delta as in the other two areas. Machine picked volume equaled hand picking during the first 2-week period of the late ginning season but declined steadily during the remainder of the season. However, from November 21 through December 3, there were 43 bales of machine-picked cotton ginned at the Upper Delta gin. Oddly, hand picking continued at about the same rate as during the middle ginning season. There was actually more hand-picked cotton ginned during the late ginning season than in the other two seasons, but it was due in part to the length of the late ginning season.

Grade of late season hand-picked cotton exceeded late season machine-picked cotton by less than two index points. Staple index, percentage of gin

Table 7.—Relationships between selected measures of cotton quality and harvesting conditions, by 2-week intervals, Upper Mississippi Delta, 1960

2-week period	Bales ginned	Seed cotton weight	Bale weight	Seed weight	Grade index	Staple Index	Days of rain	Amount rain	Gin turnout	Seed turnout	Waste
	Number	Pounds	Pounds	Pounds	index	Index	Number	Inches	Percent	Percent	Percent
						Hand Picked					
Aug. 15-27	3	1,430	512	878	102.7	34.0	1	.80	35.9	61.3	2.80
Aug. 29-Sept. 10	181	1,491	523	877	101.4	34.0	4	.55	35.1	58.9	5.80
Sept. 12-24	249	1,848	535	848	101.0	33.7	3	2.79	36.1	57.1	6.81
Sept. 26-Oct. 8	194	1,454	521	820	100.3	33.7	3	2.45	35.8	56.4	7.76
Oct. 10-22	176	1,498	509	824	97.4	33.7	4	2.72	34.1	55.1	10.86
Oct. 24-Nov. 5	169	1,541	499	823	93.7	33.0	3	.39	32.5	53.6	13.86
Nov. 7-19	199	1,563	507	823	93.8	32.9	5	1.92	32.6	52.9	14.50
Nov. 21-Dec. 3	210	1,654	495	799	90.2	32.5	2	1.20	30.2	48.6	21.22
Dec. 5-17	167	1,791	500	819	87.9	32.5	5	1.52	28.3	46.1	25.60
Dec. 19-31	120	1,981	496	785	79.8	32.2	5	1.46	25.3	39.9	34.84
						Machine Picked					
Aug. 15-27											
Aug. 29-Sept. 10	3	1,360	455	765	97.0	33.3	4	.55	33.5	56.3	10.23
Sept. 12-24	198	1,394	485	765	96.8	33.6	3	1.44	34.8	54.9	10.23
Sept. 26-Oct. 8	540	1,442	493	775	95.4	33.6	3	2.45	34.2	53.8	11.95
0ct. 10-22	301	1,466	484	787	92.7	33.6	4	2.72	33.1	53.8	13.17
Oct. 24-Nov. 5	560	1,519	489	820	90.3	33.0	3	.39	32.3	54.1	13.61
Nov. 7-19	197	1,526	485	819	88.5	32.8	5	1.92	31.9	53.7	14.44
Nov. 21-Dec. 3	73	1,558	502	848	85.8	32.3	2	1.20	32.3	54.4	13.36
Dec. 5-17	43	1,484	472	763	82.3	32.4	5	1.52	31.8	51.4	16.72
Dec. 19-31	3	1,347	425	678	82.0	33.0	5	1.46	31.6	50.4	17.97
						Total Picked					
Aug. 15-17	3	1,430	512	878	102.8	34.0	1	.80	35.9	61.3	2.80
Aug. 29-Sept. 10	184	1,489	522	875	101.3	34.0	4	.55	35.1	58.8	6.05
Sept. 12-24	447	1,444	513	811	99.1	33.7	3	1.44	35.5	56.1	8.33
Sept. 26-Oct. 8	734	1,445	500	787	96.7	33.6	3	2.45	34.7	54.5	10.84
Oct. 10-22	477	1,478	493	801	94.5	33.6	4	2.72	33.4	54.2	12.32
Oct. 24-Nov. 5	729	1,524	491	821	91.1	33.0	3	.39	32.3	54.0	13.66
Nov. 7-19	396	1,545	496	821	91.2	32.8	5	1.92	32.2	53.3	14.47
Nov. 21-Dec. 3	283	1,629	497	811	89.0	32.4	2	1.20	30.7	50.1	19.20
Dec. 5-17	210	1,728	494	808	86.8	32.5	5	1.52	29.0	47.2	23.78
Dec. 19-31	123	1,967	495	782	79.8	32.2	5	1.46	25.4	40.1	34.43

turnout, percentage of seed turnout, and percentage of waste all favored machine-picked cotton to some extent. More small farms were served by the Upper Delta gin than the other two gins. Percentage of resident labor is usually greater on the small farms which may account for the lack of fluctuation in hand-picked cotton over the entire ginning season. This factor, coupled with the weather, may also account for the good quality of early and middle season hand-picked cotton.

Entire Season: For the entire ginning season, machine-picked cotton exceeded hand picked, 1,918 bales to 1,668 bales. Grade index favored hand-picked cotton by about 2½ points, but all other quality measures favored machine-picked cotton. The Upper Delta ginning season was longer and ginnings more evenly distributed than in other areas. As an average for the Upper Delta, about 1,510 pounds of seed cotton were required to produce 500 pounds of lint with machine picking compared to 1,552 pounds for hand-picked cotton.

Table 8.—Relationships between selected measures of cotton quality and harvesting conditions, by ginning season, Upper Mississippi Delta, 1960.

Season	Bales ginned	Seed cotton weight	Bale weight	Seed weight	Grade index	Staple Index	Days of rain	Amount rain	Gin turnout	Seed turnout	Waste
	Number	Pounds	Pounds	Pounds	index	Index	Number	Inches	Percent	Percent	Percent
					Hand Picked						
Early	433	1,486	530	860	101.15	33.85	8	2.79	35.68	57.88	6.44
Middle	539	1,496	510	822	97.29	33.45	10	5.56	34.22	55.09	10.69
Late	696	1,717	500	808	88.86	32.54	17	6.10	29.56	47.73	22.70
Total	1,668	1,586	511	826	94.77	33.17	35	14.45	32.66	52.75	14.60
					Machine Picked						
Early	201	1,393	484	765	96.77	33.63	7	1.99	34.83	54.94	10.23
Middle	1,401	1,478	490	796	92.79	33.36	10	5.56	33.21	53.92	12.87
Late	316	1,526	487	817	87.00	32.66	17	6.10	31.94	53.52	14.53
Total	1,918	1,477	489	796	92.25	33.27	34	13.65	33.17	53.96	12.87
					Total Picked						
Early	634	1,457	515	830	99.76	33.78	8	2.79	35.41	56.95	7.64
Middle	1,940	1,483	495	803	94.04	33.38	10	5.56	33.49	54.24	12.27
Late	1,012	1,658	496	811	88.28	32.58	17	6.10	30.31	49.54	20.15
Total	3,586	1,528	499	810	93.42	33.23	35	14.45	32.93	53.40	13.67

The Delta

After analysis of the ginning results from each sample gin representing the Lower, Middle, and Upper Delta these data were grouped for further analysis of the entire Delta situation. (Table 9). Grade index of hand-picked cotton was higher than machine-picked cotton until the last 2 weeks of the season when only 3 bales of machine-picked cotton were ginned. However, by midseason, gin turnout favored machine-picked cotton and remained so the rest of the season. This was also true for seed turnout and staple length index. Days of rain and inches of rainfall are, by necessity, averages of the three gin areas used in the analysis.

Early Ginning Season: There were 1,012 bales of hand-picked cotton ginned in the early ginning season, amounting to 18.9 percent of all the hand-picked cotton (table 10). Machine picking accounted for only 394 bales during the same period which was 8.3 percent of all the machine picked cotton. Both methods of harvesting totaled 1,406 bales during the early ginning season which was 13.9 percent of the total crop. It required an average of 1,479 pounds of hand-picked seed cotton and waste to produce 500 pounds of lint while only 1420 pounds were required for machine-picked cotton. However, gin turnout was the only measure that favored machine-picked cotton during the early ginning season as grade index, staple index, seed turnout, and percentage of waste all favored hand-picked cotton. Two basic reasons may be advanced for the fact that the number of hand-picked bales was almost 3 times the machine-picked bales during the early ginning season. Farmers are reluctant to start machines while the cotton is still in full leaf and when danger of extensive boll damage exists. The other reason is picking costs; hand picking is not affected by the fact that 30 percent or 60 percent of the crop may be open. In contrast, the operating costs of a mechanical picker does not vary proportionately to the amount of cotton harvested in one picking.

Middle Ginning Season: The middle ginning season is the heart of the harvesting season. The cotton crop is basically matured and defoliation opens up the vegetation and allows the sun to speed up the harvesting process. Most farmers are anxious to get the crop out of the field and may use hand pickers—resident labor and hired labor—and mechanical pickers, both owned and rented machines. There were 6,360 bales ginned during the 6 weeks that comprised the middle ginning season (table 11). This was 63 percent of the entire crop. Of this amount, 3,679 bales were machine picked and 2,681 bales were hand picked. The 3,679 bales of machine-picked cotton accounted for 77.7 percent of all machine-picked cotton ginned during the entire season. Hand-picked cotton amounted to only 50 percent of all hand-picked cotton ginned for the season.

Quality-wise, there was very little difference by harvesting method during the middle ginning season. The major difference was in grade index where hand-picked cotton exceeded machine picked by about 4.5 index points. If rainfall had not retarded machine picking in the Lower Delta, the percentage of the crop harvested in the 6-week middle ginning season may well have exceeded 70 percent. The fact that some 60 to 70 percent of the cotton crop must be ginned during a 6-week period has produced some severe bottlenecks at Delta gins in the last few seasons.

Late Ginning Season: Late picking and scrapping usually starts about November 1 and continues until the crop is picked. In 1960, 23.1 percent of the cotton handled by the three sample gins was picked during the late ginning season (table 12). The number of bales picked

Table 9. Relationships between selected measures of cotton quality and harvesting conditions, by 2-week intervals, Yazoo-Mississippi Delta, 1960

2-week period	Bale ginned	Seed cotton weight	Bale weight	Seed weight	Grade index	Staple Index	Days of rain	Amount rain	Gin turnout	Seed turnout	Waste
	Number	Pounds	Pounds	Pounds	index	Index	Number	Inches	Percent	Percent	Percent
						Hand Picked					
Aug. 15-27	57	1,602	501	889	97.74	33.67	5.74	2.07	31.36	55.57	13.07
Aug. 29-Sept 10	706	1,586	528	914	99.27	33.94	4.74	1.04	33.38	57.66	8.96
Sept. 12-24	1,017	1,544	524	892	99.79	34.04	4.68	1.04	34.06	57.76	8.18
Sept. 26-Oct. 8	898	1,551	508	878	98.48	33.91	4.92	1.27	32.87	56.63	10.51
Oct. 10-22	846	1,574	498	869	96.53	33.63	2.39	.82	31.71	55.25	13.04
Oct. 24-Nov. 5	603	1,618	493	865	93.85	33.16	3.15	.68	30.65	53.57	15.78
Nov. 7-19	488	1,650	497	851	92.77	33.08	3.82	1.70	30.40	51.84	17.76
Nov. 21-Dec. 3	366	1,694	491	835	90.28	32.75	2.58	1.51	29.31	49.67	21.01
Dec. 5-17	221	1,807	501	842	88.20	32.51	5.59	1.76	28.06	46.95	24.99
Dec. 19-31	162	1,977	501	843	81.33	32.36	5.78	1.79	25.62	43.09	31.29
						Machine Picked					
Aug. 15-27											
Aug. 29-Sept. 10	196	1,439	513	774	97.63	33.33	4.98	1.95	35.66	53.77	10.56
Sept. 12-24	837	1,495	498	823	94.54	33.73	4.87	1.31	33.44	54.97	11.59
Sept. 26-Oct. 8	1,441	1,517	496	827	94.27	33.62	4.04	1.33	32.80	54.44	12.75
Oct. 10-22	1,039	1,560	494	837	92.54	33.47	3.03	1.12	31.80	53.69	14.51
Oct. 24-Nov. 5	801	1,571	486	839	88.64	33.03	3.05	4.84	31.16	53.59	15.25
Nov. 7-19	278	1,598	493	852	87.84	32.98	4.42	1.80	30.98	53.37	15.65
Nov. 21-Dec. 3	86	1,554	492	835	85.01	32.42	2.38	1.34	31.69	53.69	14.63
Dec. 5-17	51	1,537	478	792	82.06	32.57	5.31	1.62	31.26	51.56	17.17
Dec. 19-31	3	1,347	425	678	82.00	33.00	5.00	1.46	31.60	50.43	17.97
						Total Picked					
Aug. 15-17	57	1,602	501	889	97.74	33.67	5.74	2.07	31.36	55.57	13.07
Aug. 29-Sept. 10	902	1,554	525	884	98.91	33.81	4.80	1.24	33.88	56.82	9.31
Sept. 12-24	1,854	1,522	512	861	97.42	33.90	4.77	1.16	33.78	56.50	9.72
Sept. 26-Oct. 8	2,339	1,531	500	846	95.89	33.73	4.38	1.31	32.83	55.28	11.89
Oct. 10-22	1,885	1,566	496	852	94.33	33.54	2.74	.98	31.76	54.39	13.85
Oct. 24-Nov. 5	1,404	1,591	489	850	90.88	33.08	3.09	.57	30.94	53.58	15.48
Nov. 7-19	766	1,631	495	851	90.98	33.05	4.03	1.74	30.61	52.39	16.99
Nov. 21-Dec. 3	452	1,667	491	835	89.28	32.68	2.54	1.48	29.77	50.44	19.80
Dec. 5-17	272	1,757	497	832	87.05	32.52	5.54	1.74	28.66	47.81	23.52
Dec. 19-31	165	1,965	500	840	81.34	32.38	5.76	1.78	25.73	43.22	31.05

Table 10.—Relationships between selected measures of cotton quality and harvesting conditions, early ginning season, Yazoo-Mississippi Delta, 1960.

Item	Bales ginned	Bales ginned	Average seed cotton weight	Average bale weight	Average seed weight	Average grade index	Average staple index	Gin turnout	Seed turnout	Waste
	Number	Percent	Pounds	Pounds	Pounds	Index	Index	Percent	Percent	Percent
Lower Delta										
Hand	295	11.6	1,630	525	966	98.20	34.25	32.28	59.26	8.46
Machine										
Total	295	7.6	1,630	525	966	98.20	34.25	32.28	59.26	8.46
Middle Delta										
Hand	284	24.4	1,606	528	879	98.70	33.51	32.96	54.77	12.26
Machine	193	13.2	1,441	514	774	97.64	33.33	35.70	53.73	10.57
Total	477	18.1	1,539	522	837	98.27	33.44	34.07	54.35	11.58
Upper Delta										
Hand	433	26.0	1,486	530	860	101.15	33.85	35.68	57.88	6.44
Machine	201	10.5	1,393	484	765	96.77	33.63	34.83	54.94	10.23
Total	634	17.7	1,457	515	830	99.76	33.78	35.41	56.95	7.64
Total Delta										
Hand	1,012	18.9	1,562	528	896	99.60	33.87	33.93	57.41	8.66
Machine	394	8.3	1,417	499	769	97.19	33.48	35.26	54.35	10.40
Total	1,406	13.9	1,521	520	861	98.93	33.76	34.30	56.55	9.15

Table 11.—Relationships between selected measures of cotton quality and harvesting conditions, middle ginning season, Yazoo-Mississippi Delta, 1960.

Item	Bales ginned	Bales ginned	Average seed cotton weight	Average bale weight	Average seed weight	Average grade index	Average staple index	Gin turnout	Seed turnout	Waste
	Number	Percent	Pounds	Pounds	Pounds	Index	Index	Percent	Percent	Percent
Lower Delta										
Hand	1,478	58.3	1,585	504	930	98.24	34.24	31.91	58.72	9.36
Machine	1,061	78.8	1,615	492	905	92.04	34.08	30.58	56.05	13.37
Total	2,539	65.4	1,598	499	920	95.65	34.17	31.36	57.60	11.04
Middle Delta										
Hand	664	57.1	1,561	514	815	97.35	33.23	32.95	52.24	14.80
Machine	1,217	82.9	1,519	505	807	94.41	33.16	33.28	53.14	13.58
Total	1,881	71.5	1,534	508	810	95.45	33.19	33.16	52.82	14.02
Upper Delta										
Hand	539	32.3	1,496	510	822	97.29	33.45	34.22	55.09	10.69
Machine	1,401	73.0	1,478	490	796	92.79	33.36	33.21	53.92	12.87
Total	1,940	54.1	1,483	495	803	94.04	33.38	33.49	54.24	12.27
Total Delta										
Hand	2,681	50.0	1,561	508	880	97.83	33.83	32.64	56.39	10.98
Machine	3,679	77.7	1,531	495	831	93.11	33.50	32.47	54.27	13.25
Total	6,360	63.0	1,544	501	852	95.10	33.64	32.54	55.16	12.29

by hand was more than double the number machine picked during the period—1,671 bales to 659 bales. The 1,671 hand-picked bales accounted for 31.2 percent of all hand-picked cotton ginned on the sample gins. Machine-picked cotton amounted to only 13.9 percent of the entire machine-picked crop. Grade index was about 5 points higher for hand-picked cotton, but staple index, gin turnout, seed turnout, and percentage of waste all favored machine-picked cotton. Picking costs and weather conditions are again the most probable reasons that hand picking exceeded machine picking in the late ginning season.

Table 12.—Relationships between selected measures of cotton quality and harvesting conditions, late ginning season, Yazoo-Mississippi Delta, 1960.

Item	Bales ginned	Bales ginned	Average seed cotton weight	Average bale weight	Average seed weight	Average grade index	Average staple index	Gin turnout	Seed turnout	Waste
	Number	Percent	Pounds	Pounds	Pounds	Index	Index	Percent	Percent	Percent
Lower Delta										
Hand	760	30.0	1,713	492	911	92.31	33.42	28.97	53.49	17.54
Machine	286	21.2	1,737	485	908	84.31	33.30	28.05	52.39	19.56
Total	1,046	27.0	1,719	490	910	90.13	33.39	28.72	53.19	18.09
Middle Delta										
Hand	215	18.5	1,689	492	798	91.78	32.20	29.35	47.43	23.21
Machine	57	3.9	1,559	489	808	87.32	32.65	31.41	51.89	16.69
Total	272	10.3	1,661	491	800	90.84	32.29	29.78	48.37	21.85
Upper Delta										
Hand	696	41.7	1,717	500	808	88.86	32.54	29.56	47.73	22.70
Machine	316	16.5	1,526	487	817	87.00	32.66	31.94	53.52	14.53
Total	1,012	28.2	1,658	496	811	88.28	32.58	30.31	49.54	20.15
Total Delta										
Hand	1,671	31.2	1,712	495	853	90.81	32.90	29.27	50.31	20.42
Machine	659	13.9	1,620	486	856	85.86	32.94	30.21	52.89	16.90
Total	2,330	23.1	1,686	493	854	89.41	32.91	29.53	51.04	19.43

Table 13.—Bales of cotton ginned and percent of total harvested, by method of harvest, by area, and by ginning season, Yazoo-Mississippi Delta, 1960.

Item	Season					
	Early Bales ginned		Middle Bales ginned		Late Bales ginned	
	Number	Percent	Number	Percent	Number	Percent
Lower Delta						
Hand	295	11.6	1,478	58.3	760	30.1
Machine	0	0	1,061	78.8	286	21.2
Total	295	7.6	2,539	65.4	1,046	27.0
Middle Delta						
Hand	284	24.4	664	57.1	215	18.5
Machine	193	13.2	1,217	82.9	57	3.9
Total	477	18.2	1,881	71.5	272	10.3
Upper Delta						
Hand	433	26.0	539	32.3	696	41.7
Machine	201	10.5	1,401	73.0	316	16.5
Total	634	17.7	1,940	54.1	1,012	28.2
Total Delta						
Hand	1,012	18.8	2,681	50.0	1,671	31.2
Machine	394	8.3	3,679	77.8	659	13.9
Total	1,406	13.9	6,360	63.0	2,330	23.1

Total Ginning Season: The hand-picking season in the area surveyed was longer and harvesting was more evenly distributed than the machine-picking season, where most of the harvesting was concentrated in the middle ginning season (table 13). About 20 percent of the hand-picked crop was ginned in the early season, 50 percent in the middle season, and about 30 percent in the late season. The gins processed less than 10 percent of the machine-picked crop in the early season, almost 80 percent in the middle season, and just under 15 percent in the late season.

Another comparison of harvesting results and conditions by season and area are grouped by method of harvest (table 14). This sorting facilitates a direct comparison of all ginning results by method

Table 14.—Relationships between selected measures of cotton quality and harvesting conditions by ginning season and by areas, Yazoo-Mississippi Delta, 1960.

		Season								
		Early			Middle			Late		
Item	Unit	Lower Delta	Middle Delta	Upper Delta	Lower Delta	Middle Delta	Upper Delta	Lower Delta	Middle Delta	Upper Delta
Bales ginned										
Hand	Number	295	284	433	1,478	664	539	760	215	1,671
Machine	Number	0	193	201	1,061	1,217	1,401	286	57	659
Seed cotton weight										
Hand	Pounds	1,630	1,606	1,486	1,585	1,561	1,496	1,713	1,689	1,712
Machine	Pounds	0	1,441	1,393	1,615	1,519	1,478	1,737	1,559	1,620
Bale weight										
Hand	Pounds	525	528	530	504	514	510	492	492	495
Machine	Pounds	0	514	484	492	505	490	485	489	486
Seed weight										
Hand	Pounds	966	879	860	930	815	822	911	798	853
Machine	Pounds	0	774	765	905	807	796	908	808	856
Grade index										
Hand	Index	98.20	98.70	101.15	98.24	97.35	97.29	92.31	91.78	90.81
Machine	Index	0	97.64	96.77	92.04	94.41	92.79	84.31	87.32	85.86
Staple index										
Hand	Index	34.25	33.51	33.85	34.24	33.23	33.45	33.42	32.20	32.90
Machine	Index	0	33.33	33.63	34.08	33.16	33.36	33.30	32.65	32.94
Gin turnout										
Hand	Percent	32.28	32.96	35.68	31.91	32.95	34.22	28.97	29.35	29.27
Machine	Percent	0	35.70	34.83	30.58	33.28	33.21	28.05	31.41	30.21
Seed turnout										
Hand	Percent	59.26	54.77	57.88	58.72	52.24	55.09	53.49	47.43	50.31
Machine	Percent	0	53.77	54.94	56.05	53.14	53.92	52.39	51.89	52.89
Waste										
Hand	Percent	8.46	12.26	6.44	9.36	14.80	10.69	17.54	23.21	20.42
Machine	Percent	0	10.57	10.23	13.37	13.58	12.87	19.56	16.69	16.90

of harvest for each season and area of the Delta. Area and seasonal differences are readily apparent and the relationship of such differences are shown for hand and machine-picked cotton.

A comparison of the factors selected to measure cotton quality in the study for hand- and machine-picked cotton is presented in table 15. Grade index favored hand-picked cotton in all three ginning seasons, but never by as much as a full grade. Staple index favored hand-picked cotton during the early and middle season but favored machine-picked cotton in the late season. There was never a difference of as much as one sixty-fourth of an inch. Gin turnout was better in machine-picked cotton during the early and late season but was slightly in favor of hand picking in the middle season. There was more waste in machine-picked cotton during the early and middle seasons, but hand-picked cotton exhibited more waste in the late season.

In table 16 the ginning season has been ignored and comparison of quality factors resulting from ginning is made by method of harvest and area of the Delta. Grade index for hand-picked cotton did not vary as much between areas of the Delta as did machine-picked cotton. Staple length index varied little between areas or between method of harvest. In the Lower Delta, where rainfall was a definite factor, gin turnout percentage favored hand-picked cotton, but the reverse was true for the other two areas studied. The same behavior was shown by seed turnout percentage and percentage of waste as was exhibited in the gin turnout analysis.

Table 15.—Relationships between selected measures of cotton quality and harvesting conditions, by ginning season, Yazoo-Mississippi Delta, 1960

Season	Bales ginned	Seed cotton weight	Bale weight	Seed weight	Grade index	Staple index	Gin turnout	Seed turnout	Waste
		Pounds	Pounds	Pounds	Index	Index	Percent	Percent	Percent
					Hand Picked				
Early	10,12	1,562	528	896	99.60	33.87	33.93	57.41	8.66
Middle	2,681	1,561	508	880	97.83	33.83	32.64	56.39	10.98
Late	1,671	1,712	495	853	90.81	32.90	29.27	50.31	20.42
					Machine Picked				
Early	394	1,417	499	769	97.19	33.48	35.26	54.35	10.40
Middle	3,679	1,531	495	831	93.11	33.50	32.47	54.27	13.25
Late	659	1,620	486	856	85.86	32.94	30.21	52.89	16.90
					Total Picked				
Early	1,406	1,521	520	861	98.93	33.76	34.30	56.55	9.15
Middle	6,360	1,544	501	852	95.10	33.64	32.54	55.16	12.29
Late	2,330	1,686	493	854	89.41	32.91	29.53	51.04	19.43

Table 16.—Relationships between selected measures of cotton quality and harvesting conditions ,by areas, Yazoo-Mississippi Delta, 1960.

Item	Unit	Lower Delta		Middle Delta		Upper Delta	
		Hand	Machine	Hand	Machine	Hand	Machine
Bales ginned	Number	2,533	1,347	1,163	1,467	1,668	1,918
Seed Cotton Weight	Pounds	1,629	1,641	1,596	1,510	1,586	1,477
Bale weight	Pounds	503	490	513	506	511	489
Seed weight	Pounds	929	906	827	803	826	796
Grade index	Index	96.46	90.40	96.65	94.56	94.77	92.25
Staple index	Index	34.00	33.92	33.11	33.16	33.17	33.27
Gin turnout	Percent	31.07	30.05	32.29	33.52	32.66	33.17
Seed turnout	Percent	57.22	55.27	51.95	53.17	52.74	53.96
Waste	Percent	11.71	14.68	15.76	13.31	14.60	12.87

Table 17.—Cotton ginning results by method of harvest, Yazoo-Mississippi Delta, 1960.

Item	Unit	Hand picked	Machine picked
Bales ginned	Number	5,364	4,732
Seed cotton weight	Pounds	1,608	1,534
Bale weight	Pounds	508	494
Seed cotton per 500 pounds lint	Pounds	1,583	1,553
Seed weight	Pounds	875	829
Grade index	Index	95.98	92.44
Staple index	Index	33.55	33.42
Gin turnout	Percent	31.83	32.39
Seed turnout	Percent	54.69	54.09
Waste	Percent	13.48	13.52

Table 17 presents the effect of ginning results on the quality factors selected as affected by method of harvest. Area and ginning seasons have been ignored in order to compare the total bales picked by hand and machine. Because of the extent and amount of rainfall in the Lower Delta, hand picking exceeded machine picking in the areas surveyed—5,364 bales to 4,732 bales. Gin turnout percentage was better for machine-picked cotton as it required 1,553 pounds of seed cotton to produce 500 pounds of lint, compared to 1,583 pounds for hand-picked cotton. Grade index favored hand-picked cotton by only 3.5 index points and staple index, seed turnout percentage, and percentage of waste were almost identical for the two methods of harvesting.

Regression Analysis

The use of statistic and econometric procedures allow the economist to study the interrelations of variables. One such analytical technique used to estimate the relationship between one variable and one or more other variables is least-squares multiple regression.

Over 3,000 regressions were calculated during this analysis and these results were studied and summarized. Seventeen basic regression formulas were calculated by method of harvest, areas of the Delta, and season of harvest. The 17 regression models were:

1. Regression of cotton grade upon gin turnout.
2. Regression of cotton grade upon days of measurable rainfall.
3. Regression of cotton grade upon inches of rain.
4. Regression of staple length upon gin turnout.
5. Regression of staple length upon days of measurable rainfall.
6. Regression of staple length upon inches of rain.
7. Regression of gin turnout upon days of measurable rainfall.
8. Regression of gin turnout upon inches of rain.
9. Regression of ginning waste upon days of measurable rainfall.
10. Regression of ginning waste upon inches of rain.
11. Regression of seed turnout upon days of measurable rainfall.
12. Regression of seed turnout upon inches of rain.
13. Regression of cotton grade upon days of measurable rainfall and inches of rain.
14. Regression of staple length upon days of measurable rainfall and inches of rain.
15. Regression of gin turnout upon days of measurable rainfall and inches of rain.
16. Regression of seed turnout upon days of measurable rainfall and inches of rain.
17. Regression of ginning waste upon days of measurable rainfall and inches of rain.

Tables showing the correlation coefficients for each of the above regression formulas are presented in appendix Table 1 through 17. The relationship between several of the variables was quite marked while other variables exhibited little or no interrelation. A description of the more meaningful relationships are presented here in the text with the actual figures appearing in the corresponding appendix table.

Cotton Grade.—The grade of cotton, with staple length, forms the major basis in the determination of value for lint cotton. Any factor that affects the grade of cotton is important to the producer. The correlation coefficients that are shown in the appendix tables do not measure degree of causation between cotton grade and some independent variable but rather degree of correlation that exist between the two variables. Some unidentified factor may cause a change in grade but here we measure only degree of association between change in grade and change in another variable.

Correlation between cotton grade and gin turnout was uniformly better than for any other correlation calculated. Appendix table 1 indicates a significant relationship between these two variables for all seasons, areas, and method of harvest. In the Upper Delta, where the fewest days of rainfall occurred, the correlation coefficient between grade and gin turnout for hand-picked cotton was the highest at 0.784. Correlation between grade and gin turnout tended to be higher for handpicked cotton throughout the Delta. Early season cotton, either hand or machine picked did not demonstrate the degree of correlation between grade and gin turnout as cotton picked later in the harvest season.

Correlation between cotton grade and days of measurable rainfall was not as great or as uniform as that shown for gin turnout. By specific harvesting season, hand-picked cotton exhibited higher correlation between grade and days of rain than did machine-picked cotton, but for the entire picking season there was little difference. For the entire sample of 10,096 bales there was significant correlation between grade and days of measurable rainfall.

There were some specific instances of significant correlation between cotton grade and inches of rain for certain areas, seasons, and method of picking but no real trend was apparent. When the total sample was divided into hand and machine picked cotton there was significant correlation for each group but when the two methods were combined there was virtually no correlation between grade and inches of rain.

Staple Length.—Length of staple is second only to grade in determining market value of lint cotton. Correlation between staple length and gin turnout followed much the same pattern as did grade and gin turnout. Correlation was highest in the hand-picked cotton and it was also higher during the latter part of the picking season for both harvesting methods. The entire sample did show significant correlation between staple length and gin turnout but not nearly so high as that shown for grade and gin turnout.

A higher degree of correlation existed between staple length and days of rain than did staple length and inches of rainfall. The length of time the cotton remained damp or wet appeared to influence staple length more than the amount of moisture the cotton fiber was allowed to absorb. However, there was significant correlation between both staple length and days of rain and staple length and inches of rain.

Gin Turnout.—Because moisture is known to have such a marked effect on ginning results, analysis was made to study the correlation between gin turnout and days of rainfall and gin turnout and inches of rainfall. In the correlation analysis between gin turnout and days of rain, certain areas and seasons of harvest were significantly correlated while others reflected almost no correlation. The entire ginning sample revealed virtually no correlation and when the sample was divided into hand- and machine-picked cotton the correlation coefficients for each group revealed no significant correlation.

In the analysis of gin turnout and inches of rain, the pattern of significant correlation was some better than for gin turnout and days of rain but no trend was readily apparent. One interesting observation was noted for the Upper Delta during the middle ginning season. The Upper Delta had 10 days of rain during the 6-week middle ginning season as compared to 13 days for the Lower and Middle Delta areas. The coefficient of correlation between gin turnout and days of rain revealed no significant correlation for hand ($r = .044$) or machine ($r = .029$) picked cotton (appendix table 7). However, during the 10 days of rainfall there was almost twice the actual precipitation for the Upper Delta as the other areas, 5.5 inches compared to less than 3 inches for the other areas. The coefficients of correlation between gin turnout and inches of rain were 0.418 for the hand-picked cotton and 0.318 for the machine-picked cotton. Both of these coefficients indicate significant correlation (appendix table 8). Correlation between gin turnout and inches of rain was significant for the entire sample.

Ginning Waste.—Correlation between ginning waste and days of rain was significant in most instances during the middle and late picking seasons for both hand and machine picked cotton. During the early picking season, there was significant correlation between ginning waste and days of rain for hand picked cotton and little evidence of correlation at all in the machine picked cotton (appendix table 9). The only reason that suggests itself for the explanation of this phenomenon is that the early season allowed operators to withhold mechanical pickers from the fields until cotton was much dryer than that picked by hand pickers.

In the analysis of ginning waste and inches of rain the correlation coefficients were significant for most middle and late season harvesting, but were not significant for machine picked cotton during the early harvest season (appendix table 10). Also, in the analysis of ginning waste and inches of rain, there was significant correlation when the sample was divided into hand- and machine-picked cotton. When both harvesting methods were combined, however, no significant correlation was evident.

Summary and Conclusions, Cotton Harvesting Study

Mechanical cottonpickers are no longer "insurance or safety" devices to be used only when harvesting calamities threaten, but are commonplace in the Delta harvesting picture. Almost three-fourths of the Delta cotton crop is now harvested by mechanical means. Increased use of mechanical pickers plus continued use of available hand labor has caused some severe bottlenecks at many gins in the Delta during the last few ginning seasons.

While mechanical harvesters are in general use, many operators are still concerned with the effect they and other factors may have on the cotton quality. A comparison of these factors based on method of harvest revealed that the hand-picking season was longer and harvesting is more evenly distributed than is the machine-picking season. About 20 percent of the hand-picked cotton was ginned in the early season, 50 percent in the middle season, and about 30 percent in the late season. In contrast, less than 10 percent of the machine-harvested cotton was processed in the early season, almost 80 percent during the middle season, and just under 15 percent in the late season.

A comparison of the effect harvesting conditions had on factors selected to measure cotton quality for hand- and machine-picked cotton indicated that grade favored hand-picked cotton in all three ginning seasons, but never by as much as a full grade. Staple length was greater in hand-picked cotton during early and middle ginning seasons but favored machine-picked cotton in late seasons; however, there was never a difference in average staple length of as much as 1/64 inch. Gin turnout was higher for machine-picked cotton during early and late ginning seasons but was slightly less than hand-picked cotton during the middle season. There was more gin waste in machine-picked cotton during early and middle ginning seasons, but hand-picked cotton exhibited more waste during late season.

When area and harvesting conditions are ignored in order to compare ginning effect on quality factors for hand- and machine-picked cotton, the differences in quality become less apparent. Cotton grade was higher for hand-picked cotton but by the small margin of 2½ index points—95.98 or slightly above Strict Low Middling for hand-picked cotton and 92.44 or about midway between Low Middling Plus and Strict Low Middling for the machine-picked cotton. Gin turnout, contrary to popular belief, was better for the machine-picked cotton where 1,553 pounds of seed cotton produced 500 pounds of lint as compared to the 1,583 pounds of hand-picked seed cotton required for 500 pounds of lint. Staple length, percentage of seed turnout, and percentage of ginning waste were almost identical for the two methods of harvesting.

At market prices for the last few seasons, difference in grade between machine- and hand-picked cotton would favor hand-picking by $3.50 to $7.00 per bale. However, with gin turnout in favor of machine-picked cotton, the difference of 30 pounds of seed cotton would yield 9.7 pounds of lint valued at $3.20 when priced at 33 cents per pound. When all factors are considered, there seems to be little difference in the effect ginning has on the factors that affect lint value for either hand- or machine-picked cotton.

Economics of cotton harvesting are not included in this report and all results contained herein are the product of analysis of cotton after harvesting has been completed.

APPENDIX

Appendix Table 1.—Regression of cotton grade upon gin turnout by area, season and method of harvest, Yazoo-Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Grades index	98.20	0	98.70	97.64	101.15	96.77	99.60	97.10	98.93
Gin turnout—%	32.28	0	32.96	35.70	35.68	34.83	33.93	35.26	34.30
r	.236	0	.372	.173*	.408	.313	.430	.280	.272
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Grade index	98.24	92.04	97.35	94.41	97.29	92.79	97.83	93.11	95.10
Gin turnout—%	31.91	30.58	32.95	33.28	34.22	33.21	32.64	32.47	32.54
r	.329	.466	.513	.336	.566	.442	.356	.438	.371
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Grade index	92.31	84.31	91.78	87.32	88.86	87.00	90.81	85.86	89.41
Gin turnout—%	28.97	28.05	29.35	31.41	29.56	31.94	29.27	30.21	29.53
r	.313	.619	.588	.591	.663	.291	.494	.491	.418
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,663	1,918	5,364	4,732	10,096
Grade index	96.46	90.40	96.65	94.56	94.77	92.25	95.98	92.44	94.32
Gin turnout—%	31.07	30.05	32.29	33.52	32.66	33.17	31.83	32.39	32.09
r	.484	.585	.631	.454	.784	.477	.608	.547	.526

*Significant at 5 percent level. All other figures are significant at 1 percent level.

Appendix Table 2.—Regression of cotton grade upon days of measurable rainfall by area, season and method of harvest, Yazoo-Mississippi Delta, 1960

Item	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Grade index	98.20	0	98.70	97.64	101.15	96.77	96.60	97.19	98.93
Days rain	11	11	11	11	8	8	10	10	10
r	.207**	0	.152**	.021	.061	.009	.423**	.143**	.170**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Grade index	98.24	92.04	97.35	94.41	97.29	92.79	97.83	93.11	95.10
Days rain	13	13	13	13	10	10	12	12	12
r	.304**	.151**	.252**	.150**	.022	.007	.262**	.108**	.182**
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Grade index	92.31	84.31	91.78	87.32	88.86	87.00	90.81	85.86	89.41
Days rain	24	24	22	22	17	17	21	21	21
r	.326**	.080	.253**	482**	.120**	.114*	.244**	.093*	.141**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Grade index	96.46	90.40	96.65	94.56	94.77	92.25	95.98	92.44	94.32
Days rain	48	48	46	46	35	35	43	43	43
r	.220**	.210**	.128**	.175**	.290**	.231**	.077*	.105**	.105**

[1] Days of rainfall indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 3.—Regression of cotton grade upon inches of rain by area, season and method of harvest, Yazoo-Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Grade index	98.20	0	98.70	97.64	101.15	96.77	99.60	97.19	98.93
Inches rain	4.73	4.73	3.95	3.95	4.14	4.14	4.27	4.27	4.27
r	.207**	0	.150**	.126	.124**	.009	.095**	.136**	.178**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Grade index	98.24	92.04	97.35	94.41	97.29	92.79	97.83	93.11	95.10
Inches rain	2.18	2.18	2.94	2.94	5.56	5.56	3.56	3.56	3.56
r	.188**	.132**	.249**	.148**	.532**	.426**	.212**	.202**	.146**
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Grade index	92.31	84.31	91.78	87.32	88.86	87.00	90.81	85.86	89.41
Inches rain	8.67	8.67	10.28	10.28	6.10	6.10	8.35	8.35	8.35
r	.412**	.053	.268**	.465**	.268**	.274**	.183**	.220**	.027
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Grade index	96.46	90.40	96.65	94.56	94.77	92.25	95.98	92.44	94.32
Inches rain	15.58	15.58	17.17	17.17	15.80	15.80	16.18	16.18	16.18
r	.265**	.092**	.048	.138**	.090**	.294**	.104**	174**	.029

[1] Inches of rain indicated in these totals are averages for the season. *Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 4.—Regression of staple index upon gin turnout by area, season, and method of harvest, Yazoo-Mississippi Delta, 1960

Item	Lower Delta		Middle Delta		Upper Delta		Total Delta		
	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Staple index	34.25	0	33.51	33.33	33.85	33.63	33.87	33.48	33.76
Gin turnout—%	32.28	0	32.96	35.70	35.68	34.83	33.93	35.26	34.30
r	.048	0	.010	.016	.055	.072	.087**	.034	.139**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Staple index	34.24	34.08	33.23	33.16	33.45	33.36	33.83	33.50	33.64
Gin turnout—%	31.91	30.58	32.95	33.28	34.22	33.21	32.64	32.47	32.54
r	.076*	.009	.283**	.246**	.296**	.241**	.010**	.141**	.112**
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Staple index	33.42	33.30	32.20	32.65	32.54	32.66	32.90	32.94	32.91
Gin turnout—%	28.97	28.05	29.35	31.41	29.56	31.94	29.27	30.21	29.53
r	.096*	.180**	.247**	.414**	.279**	.088	.120**	.166**	.056
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Staple index	34.00	33.92	33.11	33.16	33.17	33.27	33.55	33.42	33.48
Gin turnout—%	31.07	30.05	32.29	33.52	32.66	33.17	31.83	32.39	32.09
r	.210**	.210**	.422**	.271**	.577**	.290**	.240**	.039**	.130**

*Significant at 5 percent level.
**Significant at 1 percent level.

Appendix Table 5.—Regression of staple index upon days of measurable rainfall by area, season and method of harvest, Yazoo-Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Staple index	34.25	0	33.51	33.33	33.85	33.63	33.87	33.48	33.76
Days rain	11	11	11	11	8	8	10	10	10
r	.127*	0	.128*	.068	.106**	.073	.055	.287**	.018
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Staple index	34.24	34.08	33.23	33.16	33.45	33.36	33.83	33.50	33.64
Days rain	13	13	13	13	10	10	12	12	12
r	.193**	.159**	.170**	.146**	.234**	.216**	.215**	.205**	.219**
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Staple index	33.42	33.30	32.20	32.65	32.54	32.66	32.90	32.94	32.91
Days rain	24	24	22	22	17	17	21	21	21
r	.214**	.182	.197**	.276**	076	.256**	.214**	.089*	.187**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Staple index	34.00	33.92	33.11	33.16	33.17	33.27	33.55	33.42	33.48
Days rain	48	48	46	46	35	35	43	43	43
r	.192**	.232**	.118**	.150**	144**	.090**	.111**	.150**	.130**

[1] Days of rainfall indicated in these totals are averages for the season. *Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 6.—Regression of staple index upon inches of rain by area, season, and method of harvest, Yazoo-Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Staple index	34.25	0	33.51	33.33	33.85	33.63	33.87	33.48	33.76
Inches rain	4.73	4.73	3.95	3.95	4.14	4.14	4.27	4.27	4.27
r	.127*	0	.128*	.102**	.163**	.073	.438**	.259**	.465**
Middle Season									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Staple index	34.24	34.08	33.23	33.16	33.45	33.36	33.83	33.50	33.64
Inches rain	2.18	2.18	2.94	2.94	5.56	5.56	3.56	3.56	3.56
r	.162**	.170**	.160**	.140**	.502**	.527**	.011	.164**	.079
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Staple index	33.42	33.30	32.20	32.65	32.54	32.66	32.90	32.94	32.91
Inches rain	8.67	8.67	10.28	10.28	6.10	6.10	8.35	8.35	8.35
r	.208**	.132**	.221**	.272**	.257**	.327**	.318**	.225**	.294**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Staple index	34.00	33.92	33.11	33.16	33.17	33.27	33.55	33.42	33.48
Inches rain	15.58	15.58	17.17	17.17	15.80	15.80	16.18	16.18	16.18
r	.165**	.133**	.076	.112**	.096**	.401**	.225**	.090**	.083**

[1] Inches of rain indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 7.—Regression of gin turnout upon days of measurable rainfall by area, season, and method of harvest, Yazoo-Mississippi Delta, 1960

Item	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Gin turnout—%	32.28	0	32.96	35.70	35.68	34.83	33.93	35.26	34.30
Days rain	11	11	11	11	8	8	10	10	10
r	.038	0	.371**	.192**	.253**	.081	.610**	.226**	.434**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Gin turnout—%	31.91	30.58	32.95	33.28	34.22	33.21	32.64	32.47	32.54
Days rain	13	13	13	13	10	10	12	12	12
r	.282**	.142**	.208**	.252**	.044	.029	.144**	.009	.066*
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Gin turnout—%	28.97	28.05	29.35	31.41	29.56	31.94	29.27	30.21	28.53
Days rain	24	24	22	22	17	17	21	21	21
r	.176**	.008	.298**	.295**	.010*	.071	.130**	.261**	.045
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Gin turnout—%	31.07	30.05	32.29	33.52	32.66	33.17	31.83	32.39	32.09
Days rain	48	48	46	46	35	35	43	43	43
r	.237**	.202**	.026	.307**	.293**	.176**	.039	.047	.036

[1] Days of rainfall indicated in these totals are average for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 8.—Regression of gin turnout upon inches of rain by area, season, and method of harvest, Yazoo-Mississippi Delta, 1960

Item	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Gin turnout—%	32.28	0	32.96	35.70	35.68	34.83	33.93	35.26	34.30
Inches rain	4.73	4.73	3.95	3.95	4.14	4.14	4.27	4.27	4.27
r	.038	0	.367**	.129**	.048	.081	.030	.241**	.139**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Gin turnout—%	31.91	30.58	32.95	33.28	34.22	33.21	32.64	32.47	32.54
Inches rain	2.18	2.18	2.94	2.94	5.56	5.56	3.56	3.56	3.56
r	.091**	.008	.205**	.247**	.418**	.318**	.334**	.274**	.294**
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Gin turnout—%	28.97	28.05	29.35	31.41	29.56	31.94	29.27	30.21	29.53
Inches rain	8.67	8.67	10.28	10.28	6.10	6.10	8.35	8.35	8.35
r	.293**	.009	.331**	.273*	.301**	.060	.071*	.474**	.062*
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Gin turnout—%	31.07	30.05	32.29	33.52	32.66	33.17	31.83	32.39	32.09
Inches rain	15.58	15.58	17.17	17.17	15.80	15.80	16.18	16.18	16.18
r	.223**	.005	.128**	.312**	.123**	.230**	.025	.287**	.143**

[1] Inches of rain indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 9.—Regression of ginning waste upon days of measurable rainfall, by area, season, and method of harvest, Yazoo-Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Waste—%	8.46	0	12.26	10.57	6.44	10.23	8.66	10.40	9.15
Days rain	11	11	11	11	8	8	10	10	10
r	.104	0	.228**	.062	.291**	.004	.444**	.055	.302**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Waste—%	9.36	13.37	14.80	13.58	10.69	12.87	10.98	13.25	12.29
Days rain	13	13	13	13	10	10	12	12	12
r	.303**	.283**	.293**	.178**	.022	.031	.240**	.138**	.203**
Late Season:									
Bales ginned	769	286	215	57	696	316	1,671	659	2,330
Waste—%	17.54	19.56	23.21	16.69	22.70	14.53	20.42	16.90	19.43
Days rain	24	24	22	22	17	17	21	21	21
r	.121**	.001	.239**	.377**	.095**	.122**	180**	.113**	.128**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Waste—%	11.71	14.68	15.76	13.31	14.60	12.87	13.48	13.52	13.50
Days rain	48	48	46	46	35	35	43	43	43
r	.262**	.303**	.156**	.216**	.280**	.142**	.082**	.126**	.095**

[1] Days of rainfall indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 10.—Regression of ginning waste upon inches of rain, by area, season and method of harvest, Yazoo, Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Waste—%	8.46	0	12.26	10.57	6.44	10.23	8.66	10.40	9.15
Inches rain	4.73	4.73	3.95	3.95	4.14	4.14	4.27	4.27	4.27
r	.104	0	.226**	.062	.212**	.001	.376**	.054	.378**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Waste—%	9.36	13.37	14.80	13.58	10.69	12.87	10.98	13.25	12.29
Inches rain	2.18	2.18	2.94	2.94	5.56	5.56	3.56	3.56	3.56
r	.186**	.186**	.287**	.172**	.356**	.112**	.191**	.154**	.146**
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Waste—%	17.54	19.56	23.21	16.69	22.70	14.53	20.42	16.90	19.43
Inches rain	8.67	8.67	10.28	10.28	6.10	6.10	8.35	8.35	8.35
r	.306**	.056	.266**	.359**	.328**	.038	.196**	.279**	.104**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Waste—%	11.71	14.68	15.76	13.31	11.60	12.87	13.48	13.52	13.50
Inches rain	15.58	15.58	17.17	17.17	15.80	15.80	16.18	16.18	16.18
r	.234**	.124**	.024	.215**	.064*	.078*	.132**	.161**	.021

[1] Inches of rain indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 11.—Regression of seed turnout upon days of measurable rainfall by area, season, and method of harvest, Yazoo-Mississipi Delta, 1960

Item	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Seed turnout—%	59.26	0	54.77	53.73	57.88	54.94	57.41	54.35	56.55
Days rain	11	11	11	11	8	8	10	10	10
r	.078	.001	.049	.083	.076	.056	.087**	.252**	.039
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Seed turnout—%	58.72	56.05	52.24	53.14	55.09	53.92	56.38	54.27	55.16
Days rain	13	13	13	13	10	10	12	12	12
r	.192**	.247**	.284**	.057	.003	.024	.201**	177**	.201**
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Seed turnout—%	53.49	52.39	47.43	51.89	47.73	53.52	50.31	52.89	51.04
Days rain	24	24	22	22	17	17	21	21	21
r	.065	.006	.152**	.361**	.087*	.132**	.181**	.026	.154**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Seed turnout—%	57.21	55.27	51.97	53.17	52.74	53.96	54.69	54.09	54.41
Days rain	48	48	46	46	35	35	43	43	43
r	.213**	.272**	.216**	.059	.252**	.083**	.091**	.135**	.106**

[1] Days of rainfall indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 12.—Regression of seed turnout upon inches of rain by area, season and method of harvest, Yazoo-Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Seed turnout—%	59.26	0	54.77	53.73	57.88	54.94	57.41	54.35	56.55
Inches rain	4.73	4.73	3.95	3.95	4.14	4.14	4.27	4.27	4.27
r	.078	0	.001	.043	.076	.056	.479**	.261**	.534**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Seed turnout—%	58.72	56.05	52.24	53.14	55.09	53.92	56.38	54.27	55.16
Inches rain	2.18	2.18	2.94	2.94	5.56	5.56	3.56	3.56	3.56
r	.167**	.234**	.278**	.054	.245**	.045	.040	.007	.004
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Seed turnout—%	58.49	52.39	47.43	51.89	47.73	53.52	50.31	52.89	51.04
Inches rain	8.67	8.67	10.28	10.28	6.10	6.10	8.35	8.35	8.35
r	.259**	.021	.169**	.347**	.318**	.015	.235**	.067	.182**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Seed turnout—%	57.21	55.27	51.97	53.17	52.74	53.96	54.69	54.09	54.41
Inches rain	15.58	15.58	17.17	17.17	15.80	15.80	16.18	16.18	16.18
r	.183**	.165**	.049	.053	.023	.048	.195**	.009	.120**

[1] Inches of rain indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 13.—Regression of grade upon days of measurable rainfall and inches of rain by area, season, and method of harvest, Yazoo-Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Grade index	98.20	0	98.70	97.64	101.15	96.77	99.60	97.19	98.93
Days rain	11	11	11	11	8	8	10	10	10
Inches rain	4.73	4.73	3.95	3.95	4.14	4.14	4.27	4.27	4.27
r	.209**	0	.152**	.026	.122**	.011	.426**	.143**	.232**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Grade index	98.24	92.04	97.35	94.41	97.29	92.79	97.83	93.11	95.10
Days rain	13	13	13	13	10	10	12	12	12
Inches rain	2.18	2.18	2.94	2.94	5.56	5.56	3.56	3.56	3.56
r	.367**	.153**	.282**	.176**	.630**	.500**	.280**	.205**	.198**
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Grade index	92.31	84.31	91.78	87.32	88.86	87.00	90.81	85.86	89.41
Days rain	24	24	22	22	17	17	21	21	21
Inches rain	8.67	8.67	10.28	10.28	6.10	6.10	8.35	8.35	8.35
r	.423**	.129**	.278**	.633**	.582**	.396**	.247**	.235**	.164**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Grade index	96.46	90.40	96.65	94.56	94.77	92.25	95.98	92.44	94.32
Days rain	48	48	46	46	35	35	43	43	43
Inches rain	15.58	15.58	17.17	17.17	15.80	15.80	16.18	16.18	16.18
	.543**	.256**	.279**	.190**	.326**	.455**	.171**	.179**	.106**

[1] Days of rainfall and inches of rain indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 14.—Regression of staple index upon days of measurable rainfall and inches of rain by area, season and method of harvest,, Yazoo-Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Staple index	34.25	0	33.51	33.33	33.85	33.63	33.87	33.48	33.76
Days rain	11	11	11	11	8	8	10	10	10
Inches rain	4.73	4.73	3.95	3.95	4.14	4.14	4.27	4.27	4.27
r	.128*	0	.129*	.299**	.280**	.074	.448**	.288**	.471**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Staple index	34.24	34.08	33.23	33.16	33.45	33.36	33.83	33.50	33.64
Days rain	13	13	13	13	10	10	12	12	12
Inches rain	2.18	2.18	2.94	2.94	5.56	5.56	3.56	3.56	3.56
r	.195**	.170**	.519**	.299**	.505**	.531**	.238**	.226**	.220**
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Staple index	33.42	33.30	32.20	32.65	32.54	32.66	32.90	32.94	32.91
Days rain	24	24	22	22	17	17	21	21	21
Inches rain	8.67	8.67	10.28	10.28	6.10	6.10	8.35	8.35	8.35
r	.240**	.135**	.262**	.293**	.322**	.336**	.319**	.244**	.294**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Staple index	34.00	33.92	33.11	33.16	33.17	33.27	33.55	33.42	33.48
Days rain	48	48	46	46	35	35	43	43	43
Inches rain	15.58	15.58	17.17	17.17	15.80	15.80	16.18	16.18	16.18
r	.399**	.256**	.303**	.170**	.192**	.465**	.322**	.153**	.199**

[1] Days of rainfall and inches of rain indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 15.—Regression of gin turnout upon days of measurable rainfall and inches of rain by area, season and method of harvest, Yazoo-Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Gin turnout—%	32.28	0	32.96	35.70	35.68	34.83	33.93	35.26	34.30
Days rain	11	11	11	11	8	8	10	10	10
Inches rain	4.73	4.73	3.95	3.95	4.14	4.14	4.27	4.27	4.27
r	.039	0	.371**	.078	.269**	.081	.616**	.241**	.476**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Gin turnout—%	31.91	30.58	32.95	33.28	34.22	33.21	32.64	32.47	32.54
Days rain	13	13	13	13	10	10	12	12	12
Inches rain	2.18	2.18	2.94	2.94	5.56	5.56	3.56	3.56	3.56
r	.479**	.384**	.232**	.358**	.538**	.388**	.335**	.298**	.299**
Late Season:									
Bales ginned	769	286	215	57	696	316	1,671	659	2,330
Gin turnout—%	28.97	28.05	29.33	31.41	29.56	31.94	29.27	30.21	29.53
Days rain	24	24	22	22	17	17	21	21	21
Inches rain	8.67	8.67	10.28	10.28	6.10	6.10	8.35	8.35	8.35
r	.293**	.108**	.382**	.616**	.606**	.071	.131**	.483**	.128**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1.668	1.918	5,364	4,732	10,096
Gin turnout—%	31.07	30.05	32.29	33.52	32.66	33.17	31.83	32.39	32.09
Days rain	48	48	46	46	35	35	43	43	43
Inches rain	15.58	15.58	17.17	17.17	15.80	15.80	16.18	16.18	16.18
r	.515**	.357**	.247**	.315**	.346**	.352**	.040	.296**	.145**

[1] Days of rainfall and inches of rain indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 16.—Regression of ginning waste upon days of measurable rainfall and inches of rain, by area, season and method of harvest, Yazoo-Mississippi Delta, 1960

	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
Item	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Waste—%	8.46	0	12.26	10.57	6.44	10.23	8.66	10.40	9.15
Days rain	11	11	11	11	8	8	10	10	10
Inches rain	4.73	4.73	3.95	3.95	4.14	4.14	4.27	4.27	4.27
r	.104	0	.228**	.043	.165**	.001	.559**	.056	.457**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Waste—%	9.36	13.37	14.80	13.58	10.69	12.87	10.98	13.25	12.29
Days rain	13	13	13	13	10	10	12	12	12
Inches rain	2.18	2.18	2.94	2.94	5.56	5.56	3.56	3.56	3.56
r	.368**	.343**	.396**	.304**	.447**	.152**	.256**	.177**	.215**
Late Season:									
Bales ginned	769	286	215	57	696	316	1,671	659	2,330
Waste—%	17.54	19.56	23.21	16.69	22.70	14.53	20.42	16.90	19.43
Days rain	24	24	22	22	17	17	21	21	21
Inches rain	8.67	8.67	10.28	10.28	6.10	6.10	8.35	8.35	8.35
r	.316**	.064	.309**	.587**	.637**	.197**	.209**	.301**	.131**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Waste—%	11.71	14.68	15.76	13.31	14.60	12.87	13.48	13.52	13.50
Days rain	48	48	46	46	35	35	43	43	43
Inches rain	15.58	15.58	17.17	17.17	15.80	15.80	16.18	16.18	16.18
r	.555**	.380**	.291**	.291**	.305**	.192**	.203**	.175**	.115**

[1] Days of rainfall and inches of rain indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

Appendix Table 17.—Regression of seed turnout upon days of measurable rainfall and inches of rain by area, season and method of harvest, Yazoo-Mississippi Delta, 1960

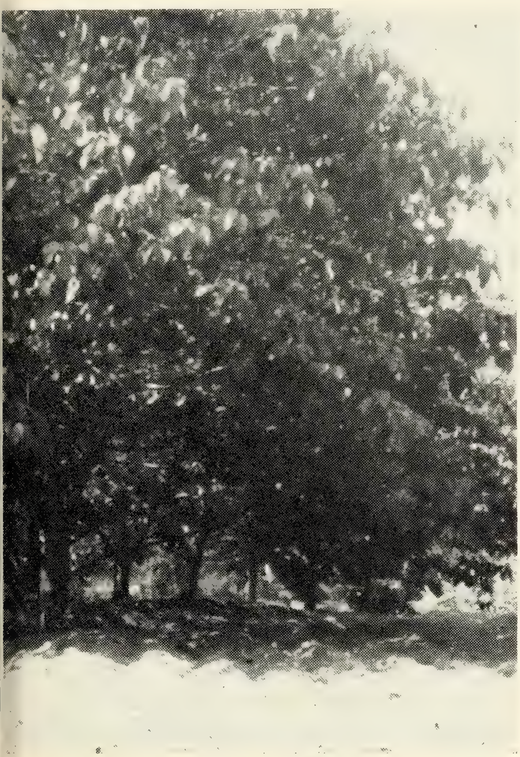
Item	Lower Delta		Middle Delta		Upper Delta		Total Delta[1]		
	Hand	Machine	Hand	Machine	Hand	Machine	Hand	Machine	All methods
Early Season:									
Bales ginned	295	0	284	193	433	201	1,012	394	1,406
Seed turnout—%	59.26	0	54.77	53.73	57.88	54.94	57.41	54.35	56.55
Days rain	11	11	11	11	8	8	10	10	10
Inches rain	4.73	4.73	3.95	3.95	4.14	4.14	4.27	4.27	4.27
r	.079	0	.003	.048	.301**	.057	.481**	.262**	.534**
Middle Season:									
Bales ginned	1,478	1,061	664	1,217	539	1,401	2,681	3,679	6,360
Seed turnout—%	58.72	56.05	52.24	53.14	55.09	53.92	56.38	54.27	55.16
Days rain	13	13	13	13	10	10	12	12	12
Inches rain	2.18	2.18	2.94	2.94	5.56	5.56	3.56	3.56	3.56
r	.193**	.247**	.423**	.157**	.299**	.045	.210**	.193**	.221**
Late Season:									
Bales ginned	760	286	215	57	696	316	1,671	659	2,330
Seed turnout—%	53.49	52.39	47.43	51.89	47.73	53.52	50.31	52.89	51.04
Days rain	24	24	22	22	17	17	21	21	21
Inches rain	8.67	8.67	10.28	10.28	6.10	6.10	8.35	8.35	8.35
r	.282**	.029	.198**	.488**	.616**	.261**	.239**	.121**	.189**
All Seasons:									
Bales ginned	2,533	1,347	1,163	1,467	1,668	1,918	5,364	4,732	10,096
Seed turnout—%	57.21	55.27	51.97	53.17	52.74	52.96	54.69	54.09	54.41
Days rain	48	48	46	46	35	35	43	43	43
Inches rain	15.58	15.58	17.17	17.17	15.80	15.80	16.18	16.18	16.18
r	.444**	.294**	.295**	.059	.263**	.086**	.275**	.152**	.115**

[1] Days of rainfall and inches of rain indicated in these totals are averages for the season.

*Significant at 5 percent level. **Significant at 1 percent level.

BULLETIN 696 NOVEMBER 1964

Cultivation Of Tung



for
Economic Production
Leaf Spot Reduction
Spring Frost Protection

by

W. W. KILBY, C. B. SHEAR,
T. VAN DER ZWET

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The Cultivation Of Tung

By W. W. KILBY, C. B. SHEAR, and T. VAN DER ZWET[1] [2]

Soil type, orchard site, tree variety, planting distance, fertilization, and schedule of orchard management operations are all important considerations in the successful production of tung. No other single factor, however, affects growth, yield, and the general well-being of the tung tree so much as does cultivation.

Cultivation has three main purposes: to change the structure of the soil, to control weeds, and to manage crop residues. These effects of cultivation have many ramifications which influence many aspects of tung production. This paper will deal with cultivation as it affects growth and production of trees and the relation of cultivation to the development of the angular leaf-spot disease and to spring frost injury.

Growth and Production

Results of cultural experiments have demonstrated that competition from grass and other weeds greatly limits the growth of newly planted tung trees. The exact causes of the detrimental effects of weeds are still undetermined. There are a number of ways, however, in which weeds have been shown to adversely affect the tung tree. Weed roots, particularly those of grasses, are very fine and almost completely fill the upper 6 to 12 inches of the soil. Tung roots are much coarser and less prolific than grass roots and cannot compete with them. When conditions are favorable, fibrous tung roots concentrate in the top 6 inches of soil. Trees growing in a millet cover-crop, however, have been observed to produce only about half the quantity of fibrous roots that are produced by trees receiving good tillage (7). It was also observed on trees growing in 200-gallon cylinders of Lakeland fine sand, one-half of the surface of which was kept free from grasses and weeds, that the volume of tung roots was not only greater in the soil on the weed-free side but that tung roots that started out under the weeds grew toward the clean-cultivated side of the cylinder.

Competition for water and nutrients have been considered by many to be mainly responsible for the detrimental effects of weeds. Many experiments, however, have been undertaken to attempt to identify and evaluate the relative importance of the factors responsible for the effects of weeds on tung.

Merrill and Kilby (6) demonstrated that, even with adequate irrigation, newly planted tung trees that were hoed made significantly more growth and produced more branches than did trees left uncultivated. Unirrigated, mulched trees made significantly more growth than did unirrigated, uncultivated trees. These results indicate that conservation of moisture is important but is not entirely responsible for the beneficial effects of cultivation.

Drosdoff, et al. (1) compared effects on young tung trees of flat hoeing and cultivation to depths of 3 to 4 or 6 to 8 inches. They found no significant effects of depth of cultivation on growth and concluded that the removal of weed competition was primarily responsible for the beneficial effects of cultivation and that stirring the soil was unimportant.

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[2] The authors wish to make the following acknowledgements: Damon Palmer of the Soil Conservation Service, Purvis, Miss., for the photograph used in Figure 1; W. A. Lewis, Agricultural Research Technician, Crops Research Division, for preparation of photographic prints used in the other figures.

Attempts to overcome the effects of weeds by supplying what were believed to be luxury levels of moisture and nutrients were unsuccessful in an experiment on trees planted in Lakeland fine sand in metal cylinders (7). In a similar experiment trees were grown in cylinders in Lakeland fine sand to which forced aeration was applied in addition to sufficient moisture and nutrients. With the addition of aeration, trees in Bermudagrass sod grew as well as did those kept free from grass. This finding of the importance of aeration for the growth of tung is in keeping with the common observation of the extensive development of tung roots in the surface soil, especially under trees casting dense shade, or where the surface of the soil is protected by mulch.

Growth and yield of mature trees also can be greatly reduced by weed competition. In an experiment at Agricola, Miss., (3), the effects on tung of a crimson clover cover crop plus 3 or 4 cultivations per year were compared with the effects of Bahiagrass sod with no cultivation. From the beginning of the experiment in 1957, through 1961, the trees growing in sod made only 75 percent as great an increase in cross-sectional area and produced only 88 percent as much fruit from 1957 through 1962 as did trees in the plots with cover crop plus cultivation. During the last 3 years of the experiment, as the detrimental effects of the grass accumulated, the trees in the Bahiagrass plots produced only 55 percent as much fruit as did those in the cover-crop-plus-cultivation plots (table 1). While exceeding the sod-grown trees in yield, the cultivated trees also were making more growth. Thus, one could expect the yield differences to become greater each year. After 4 years, the trees growing in sod showed much dead wood while those receiving cultivation did not (see figure 1). The trees growing in sod suffered much more winter killing in the severe winters of 1961-62 and 1962-63 than did the cultivated trees.

The competition between grass and tung for moisture often is dramatically demonstrated during drought periods. Trees growing in sod wilt much earlier than do trees in orchards which have been kept clean cultivated. The part of the growing season during which a moisture stress occurs will determine the nature and extent of its effects on growth and yield.

If weather conditions are favorable, shoot growth and fruit enlargement take place from April to July (2). Oil build-up in the fruit begins at about the time shoot growth and fruit enlargement cease, and flower-bud differentiation occurs during the same period (5).

Failure to conserve moisture by thor-

Table 1. Comparison of growth and yields of sod-grown and cultivated trees growing at Agricola, Miss.

	Growth increase cross-sectional areas of trunk (sq. inches)		Yields Tons/acre @ 15% moisture			
Treatment	1957-1961	1959	1960	1961	1962	Average
Crimson clover 3-4 cultivations	18.6	1.49	.96	2.48	.32	1.31
Bahiagrass no cultivation	14.0	1.27	.59	1.66	.13	.90
		N.S.	.001	.001	.001	

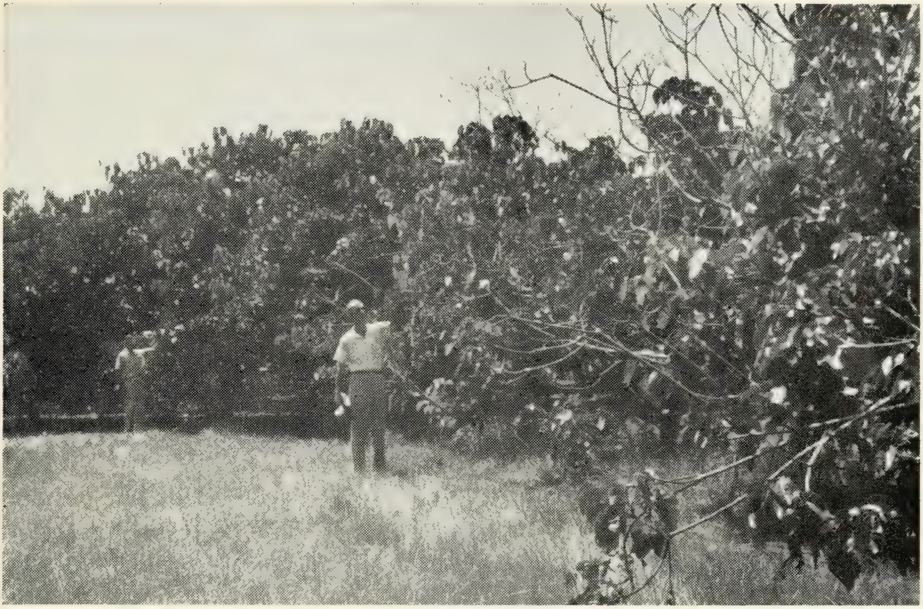

Figure 1. Comparison of cultivated and sod-grown tung trees. Trees in background were cultivated following crimson clover. Trees in foreground were in Bahiagrass sod. Note winterkilling on trees in sod.

ough cultivation during a dry spring may limit shoot growth, thereby limiting the number and area of the leaves which must manufacture the food required for oil synthesis and pistillate fruit-bud differentiation. Recent studies have shown that moisture stress during the period of oil synthesis also can reduce the oil content of the fruit. The importance of moisture conservation throughout the entire growing period thus becomes obvious, and clean culivation is the most effective and economical means of conserving soil moisture.

Angular Leaf Spot

Since the first serious outbreak in the summer of 1953, angular leaf spot has been the most serious disease of tung Even though the disease caused a serious reduction in oil content of fruit in 1956 and 1958 only, it remains a potential threat. Whenever the trees set a medium to heavy crop and the weather conditions during that season are favorable for development of the disease, leaf spot can cause a reduction of as much as 3 percentage units in the oil content of the fruit (17). Such a reduction amounts to a loss of 60 pounds of oil per ton of fruit, or $14.40 per ton with tung oil selling at $0.24 per pound.

The organism causing tung leaf spot is a fungus which completes its life cycle in two stages (14). During the summer, the parasitic stage **(Cercospora aleuritidis)** produces conidiospores on the angularly shaped leaf spots. These spores are the source of new infections throughout the growing season. When the leaves drop, the organism changes its mode of life and becomes saprophytic. During the late winter and early spring, fruiting bodies of the sexual stage of the disease organism **(Mycosphaerella aleuritidis)** develop in the spots on the dead leaves on the orchard floor. When conditions of temperature and moisture become favorable, the fruiting bodies discharge ascospores which cause the first infections on the newly developing tung leaves.

Studies by van der Zwet and Kilby (16) and subsequent observations have shown that, during and shortly after rainfall, ascospore discharge may start as early as the first of March and continue into August. The largest discharges, however, usually occur during March and April. Volunteer seedlings growing in the tree row, where concentrations of old leaves is especially heavy, become much more severely infected than do volunteers in the middles, where the old leaves have been destroyed by cutivation (15). These observations and preliminary cultivation experiments pointed toward thorough destruction of the old leaves through cultivation as a possible practical means of leaf spot control.

Kilby, et al. (4) reported that, in an experiment in which all leaves were removed from an isolated orchard by raking and burning, initial infection of volunteer seedlings did not occur until June 1, approximately 2 months later than on seedlings in commercial orchards. In May of the second year of the test, seedlings in the clean orchard had only 12.4 per cent of their leaves infected with an average of 5.9 spots per diseased leaf as compared with 43.6 percent infected leaves averaging 35.5 spots per diseased leaf on seedlings in an uncultivated orchard (19). Even though nearly 100 percent of the leaves on volunteer seedlings in both orchards were infected by the first of August, spots per diseased leaf on these volunteers averaged only 26.9 in the clean orchard as compared with 161.0 in the uncultivated orchard. In both years, the reduction in infection of mature trees resulting from clean cultivation still was apparent as late as September.

In another experiment, greenhouse-grown seedlings planted in cultivated plots had only 7 percent as many spots per leaf in July as did seedlings planted in uncultivated plots. On July 10, leaves on terminals of mature trees in the cultivated plots had ony 27 percent as many spots as did those on trees in the uncultivated plots, and by mid-August this figure had increased only to 50 percent (18). Figure 2 shows leaf-spot deveopment on volunteers in an uncultivated orchard in early June.

Though none of the sanitation experiments so far carried out has been subject to weather conditions conducive to severe leaf-spot infection, all the evidence accumulated indicates that thorough cultivation that will destroy most of the old leaves before ascospores have been discharged can be a significant factor in the reduction of leaf spot infection. The ultimate test of sanitation as an effective control for angular leaf spot must await the occurrence of an epidemic year for the disease. Nevertheless, significant reductions in the severity of the disease by thorough cultivation in late winter before leaves appear on the trees seem probable. Such cultivation, done annually, should progressively reduce innoculum to the point that, even in years when conditions are optimum for development of the disease, it may not become severe early enough to cause a reduction in oil content of the fruit.

Frost Protection

In 13 of the 26 years since 1939, late spring frosts have been responsible for losses ranging from 26 to 96 percent of the potential tung crop. With the exception of the freeze of March 27, 1955, which detroyed virtually the entire crop, damage has been scattered throughout the tung-producing area, and, usually, the losses have depended on differences in temperatures of less than 2 degrees F. Any practice which might prevent the temperature from dropping below the critical point for the buds at their stage of development at the time of exposure could, in many years, make a great dif-

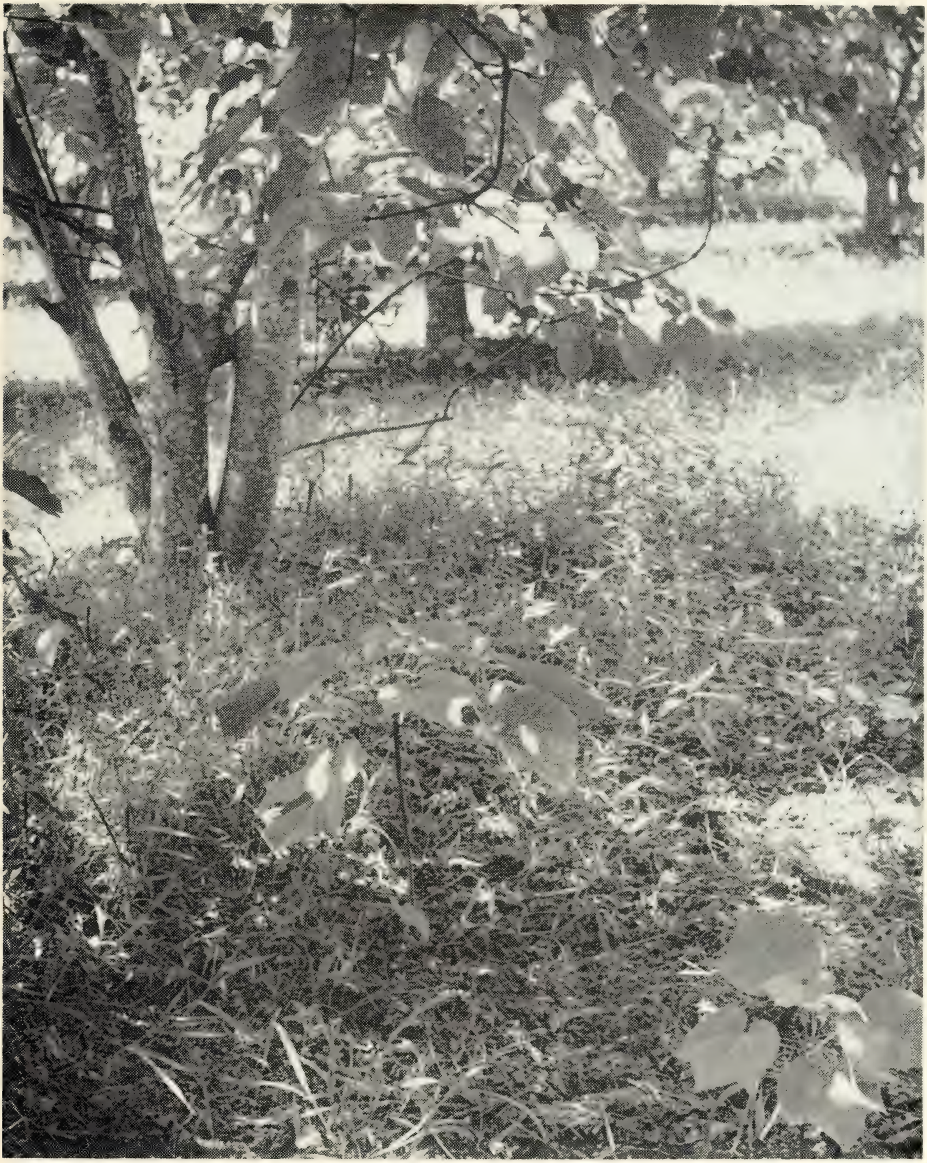

Figure 2. Uncultivated orchard showing leaf-spot infection on volunteer tung seedlings. Photographed in early June. Compare with figure 5.

ference in the extent of crop losses in areas where the temperature was near the critical point for tung blossoms.

A number of methods for preventing loss of radiant heat have been used with varying degrees of success on many crops. These include the use of smoke blankets, wind machines, and sprinkling with water. None of these methods are feasible for tung. Artificial heating by methods such as the use of oil heaters is too costly to be practical for tung.

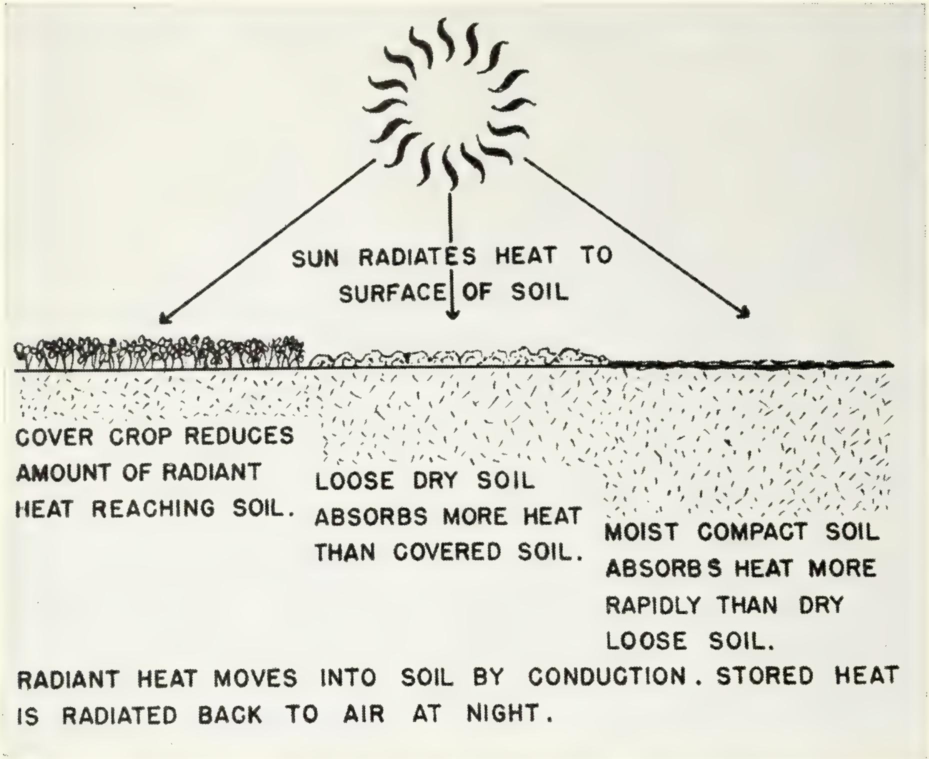
SUN RADIATES HEAT TO SURFACE OF SOIL
COVER CROP REDUCES AMOUNT OF RADIANT HEAT REACHING SOIL.
LOOSE DRY SOIL ABSORBS MORE HEAT THAN COVERED SOIL.
MOIST COMPACT SOIL ABSORBS HEAT MORE RAPIDLY THAN DRY LOOSE SOIL.
RADIANT HEAT MOVES INTO SOIL BY CONDUCTION. STORED HEAT IS RADIATED BACK TO AIR AT NIGHT.

Figure 3. Proper preparation of the soil can create a reservoir for the sun's energy available as a source of heat to protect developing flower buds against radiation frosts.

The effectiveness of early cultivation in reducing damage to orchard crops from radiation frosts has been pointed out by many writers (8,9,10,11,12). A firm, clean-cultivated soil absorbs large quantities of heat on a sunny day (see figure 3). At the latitude in which most of the Tung Belt lies, approximately 224,840 BTU per acre per minute of radiant energy reaches the surface of the ground at noon on a clear day late in March. For the whole daylight period, the average is about 160,600 BTU per acre per minute, or 115,632,000 BTU per acre for the 12-hour period from 6:00 a.m. to 6:00 p.m.

Though color, texture, and moisture content greatly affect the rate of absorption by and release of heat from the soil, a clean-cultivated, dark-colored clay soil absorbs nearly 80 percent of the radiation that reaches its surface. A grass-covered soil, however, absorbs only about 65 percent. Thus, about 17,344,800 BTU per acre per day more energy is absorbed by clean than by weedy or trashy soil. Much of this radiant energy is stored in the soil, but on a night of high radiation, heat is lost from a clean-cultivated soil at the rate of approximately 1,000,000 BTU per acre per hour, or 12,000,000 BTU during a 12-hour night. This is more heat than is released in the burning of 2 barrels of crude oil.

On a clear, windless night following a sunny day, the temperature 4½ feet above a well-settled, cultivated soil will be 1 to 3 degrees F. higher than the temperature the same distance above a soil protected by a cover crop, grass, or mulch. The soil must be cultivated long enough before a frost to have permitted it to settle to a firm surface. A mulch of loose, freshly culivated soil can prevent absorption of radiant energy almost as effectively as a mulch of straw or weeds.

Thorough cultivation of the tung orchard 2 or 3 weeks before blossom time will put the soil in a condition to serve as an effective accumulator of radiant energy. Should the orchard be exposed to a radiation frost at the critical stage of bloom, this preparation of the soil may make the difference in temperature necessary to save the crop. Thus, what should be considered as a good orchard practice, regardless of the frost hazard, takes on the added value of frost insurance.

Obviously, a winter cover crop cannot be grown if early cultivation is practiced. Each grower must weigh the fertilizer and forage value of a cover crop against the advantages of clean cultivation for frost protection and reduction of leaf-spot infection.

Cultivation Machinery and Techniques

Machinery to be used in the tung orchard should be purchased wisely, with specific operations in mind. The cheapest or most readily available type of disk or harrow may do an unsatisfactory job in the orchard and, in the long run, be a poor investment.

Most tung orchards are planted on rolling terrain and, therefore, should be planted on the contour. In such orchards, the trees should be planted on the contour rows but not on top of prepared terraces. For the first 2 years after planting, disking should be done with a one-way disk (see figure 4) so that the soil will be turned toward the tree row. This will develop each tree row into a terrace having a gentle slope from the tree row to the center of the middle (see figure 5). In this way, good erosion control and drainage will be obtained and, at the same time, a gently sloping terrace with a broad base will be developed. Such a terrace can be cultivated easily and is well adapted to mechanical harvesting.

Care should be taken not to develop the terrace too high or too steep. In orchards newly planted in old cultivated fields, some hand hoeing in the tree row may be necessary the first year or two to satisfactorily control weeds.

After the terrace has been developed, a standard off-set disk should be used for subsequent cultivations (see figure 6). The front section of this disk cuts the soil away from the tree row, and the back section lays it back in place so that there is little or no displacement of the terrace. The middles may be cultivated with either an off-set or a tandem disk (see figure 7). A tandem disk should not be used along the tree row, however, as it will bar off the tree row, exposing large roots and eventually flattening the terrace (see figure 8).

The above described deep, row-to-row cultivation should be done in late winter so that all trash, old leaves, and vegetation will have been turned under and the soil had ample opportunity to settle before tree growth starts. This is essential if maximum benefit toward frost protection and leaf-spot control is to be realized from the cultivation.

When new growth of grass and other weeds begins in the spring, a wide, flexible spring-tooth harrow will do an adequate job of cultivation (see figure 9). This implement not only will destroy the weeds but will tend to level out any irregularities in the terraces. The spring-tooth harrow has a distinct advantage over a disk for summer cultivation in that it does not cut off surface feeding roots but tends to move them in the soil as would a comb, resulting in a minimum of

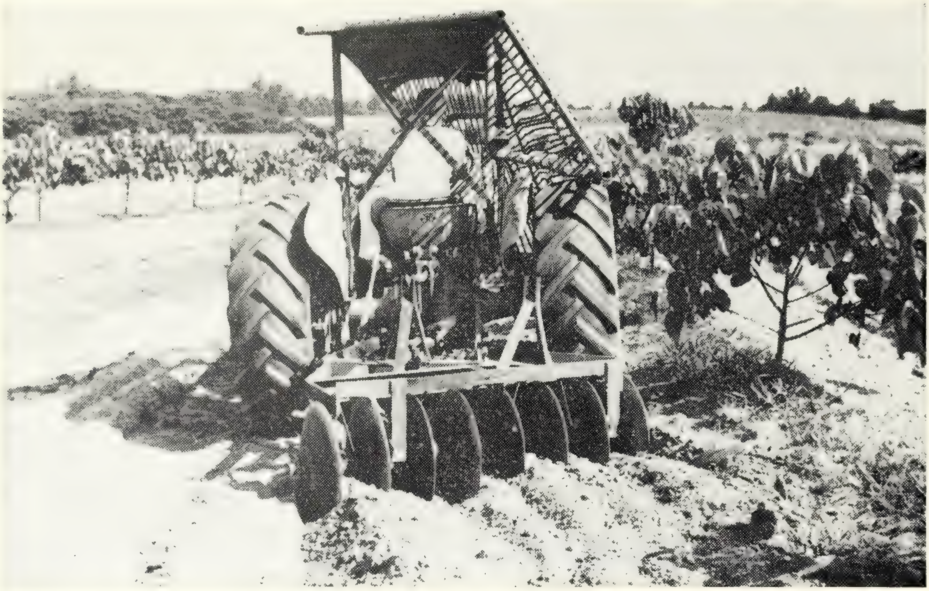

Figure 4. A one-way disk should be used to build terraces along the contoured tree rows in young orchards. By adjusting its pitch, this implement can be used to maintain these terraces after they have been formed.

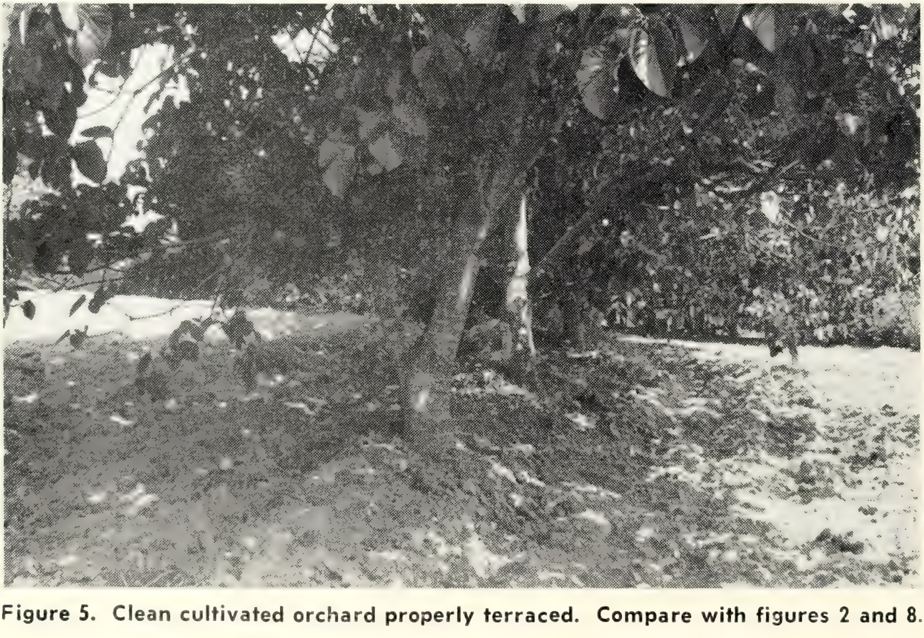

Figure 5. Clean cultivated orchard properly terraced. Compare with figures 2 and 8.

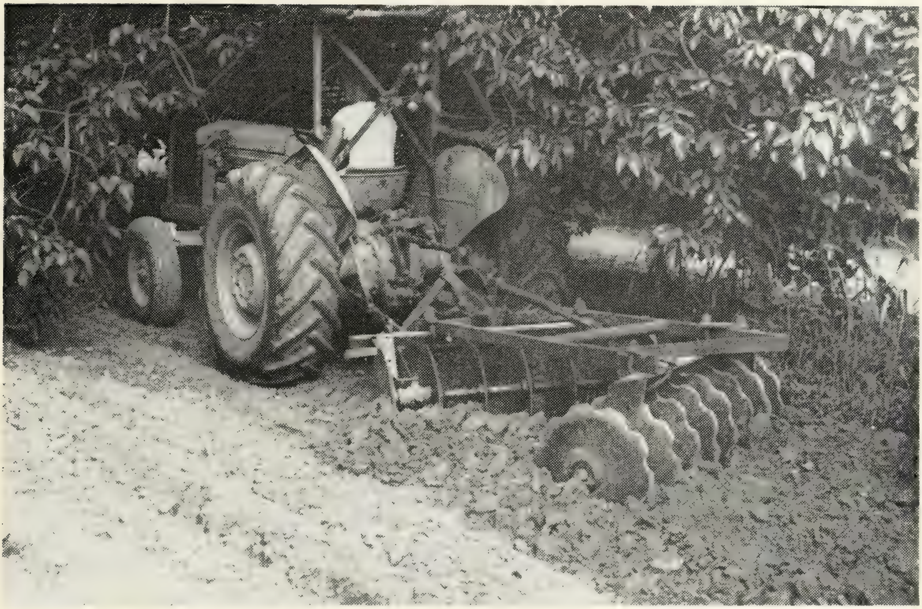

Figure 6. An off-set disk can be used to cultivate close to the tree row without destroying the terrace or barring off as shown in figure 8.

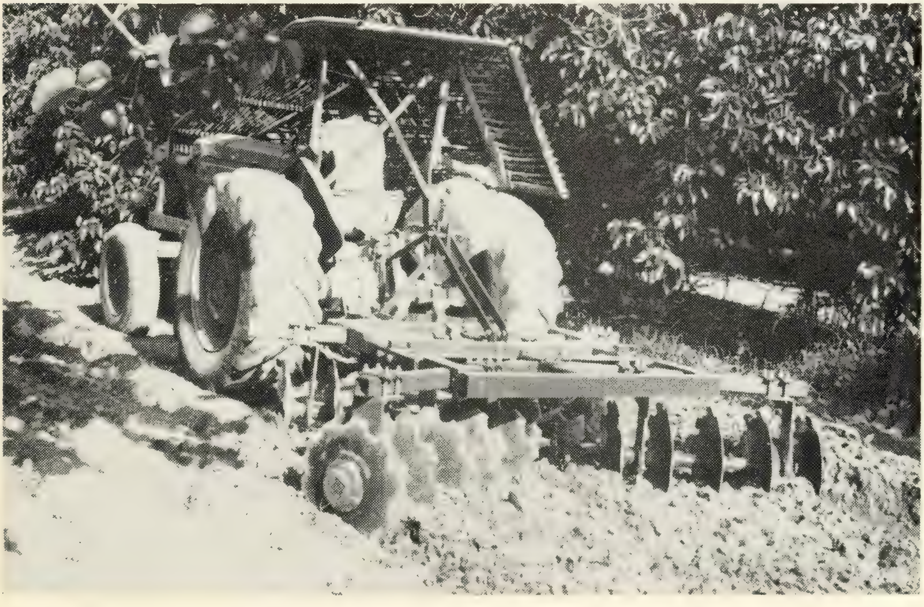

Figure 7. A wide tandem disk can be used to turn under old leaves and weeds in the middles.

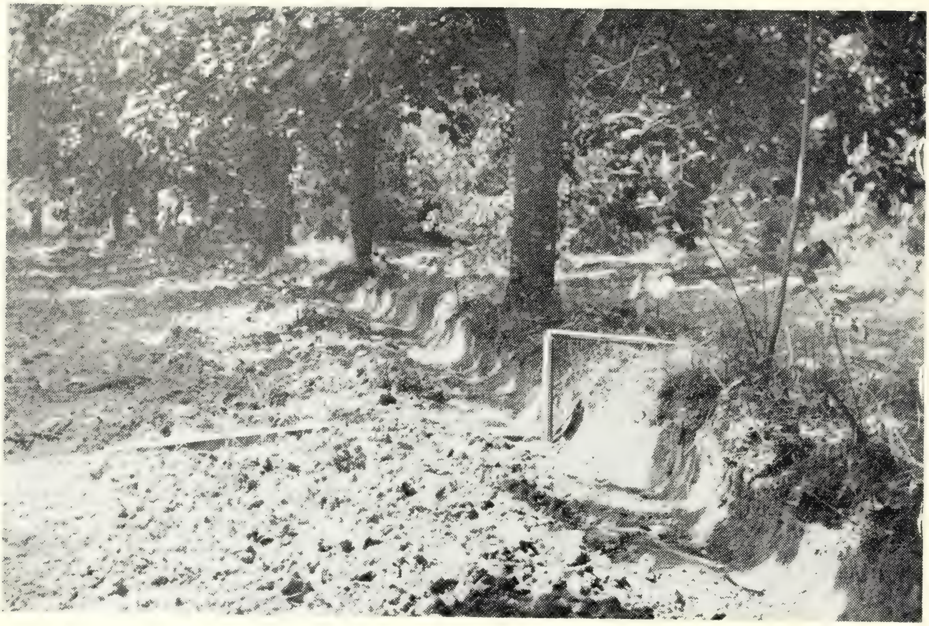

Figure 8. Tree row barred-off and terrace flattened by continued use of off-set or tandem disk along the row. Compare with figure 5.

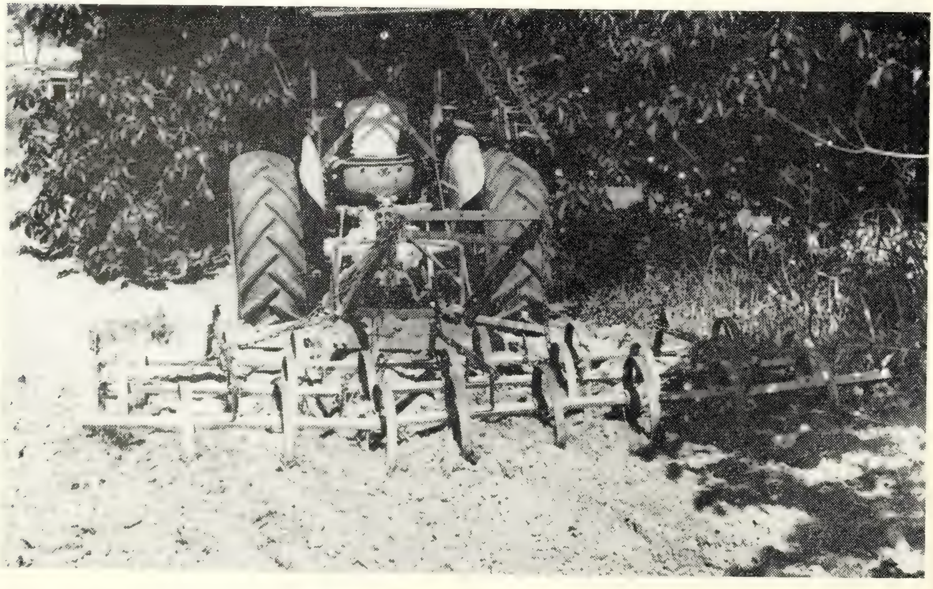

Figure 9. A spring-tooth harrow will maintain a weed-free orchard during the summer if spring cultivation has been thorough. This implement is less destructive to tung feeding roots than is a disk.

damage. During prolonged dry periods, the harrow may be used to maintain a loose surface soil which will act as a dust mulch and greatly reduce loss of subsoil moisture.

Since the draft of the spring-tooth harrow is considerably less than that of the disk harrow, a much wider spring-tooth may be used on the same tractor which pulls the smaller disk. Thus, about two cultivations can be done with the spring-tooth for the cost of one with the disk.

The smoother the surface of the soil after the last cultivation in late summer, the more efficiently the harvesting can be done. A smooth surface is essential for mechanical harvesting, and hand harvesting will be done more rapidly and more completely in an orchard with a smooth surface. A chain-link harrow (see figure 10) does an excellent job of smoothing the surface when used on freshly harrowed or otherwise loosened soil. A log chain stretched between the rear corners of the chain-link harrow will smooth out any furrows left by the teeth of the harrow.

Finer textured soils prepared in the above-described manner will generally become firm enough to prevent the tung fruit from sinking in when they drop at maturity. In very sandy soils, however, the last operation in late summer should be the use of a heavy roller to compact the surface.

In contoured orchards which cannot be cross-cultivated, tung seedlings, briars, and other weeds develop between the trees in the row. The most efficient and permanent method of eradicating these weeds is to spray them with the herbicide 2,4,5-T. A formulation containing low volatile esters of 2,4,5-T should be applied at a concentration of 3 pounds of acid equivalent per 100 gallons of water. Spraying should either be done as soon as briars are in full leaf or after new canes have produced sufficient foliage to

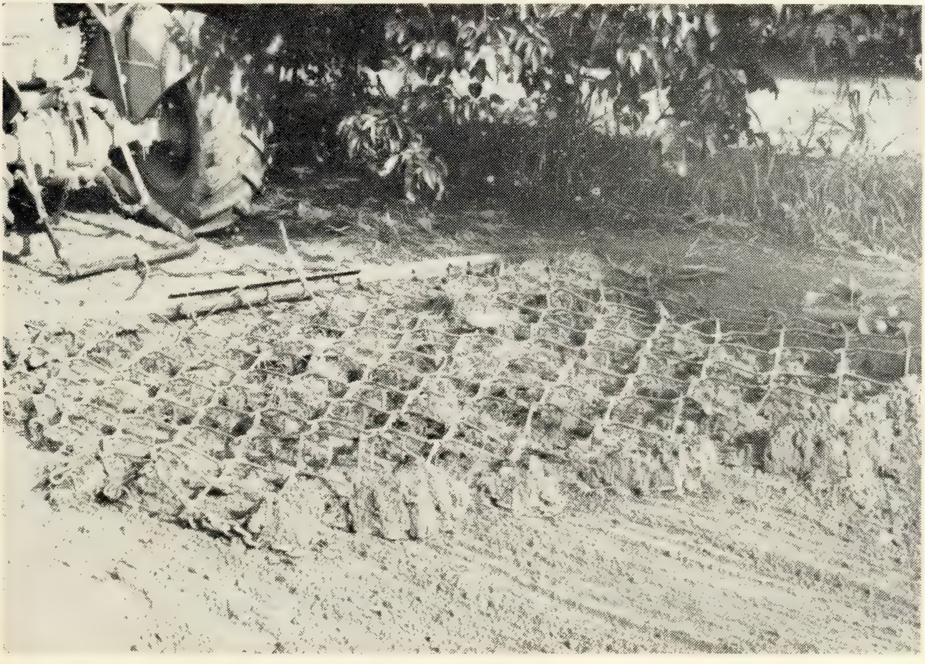

Figure 10. A chain-link harrow does an excellent job of smoothing freshly harrowed soil.

absorb a lethal dose. The best period is during May and June. Detailed instructions for spraying have been described by Sitton and Lewis (13).

The importance of clean tree rows must be emphasized. A thorough job of harvesting cannot be done, either by hand or machine, if tree rows are grown up in briars and volunteers. Such undergrowth also traps leaves which cannot be turned under with normal cultivation and, therefore, remain as a source of leaf-spot inoculum.

Timely and effective use of the proper cultivation equipment will pay greater returns on the money spent than will any other single orchard practice. In fact, much of the value of other cultural procedures, especially of fertilization may not be realized if cultivation is neglected.

RECOMMENDED CULTIVATION SCHEDULE

Newly planted orchards

Keep contoured tree rows free of weeds and construct terraces with one-way disk. After desired slope has been developed (second or third year), an off-set disk should be used to maintain terraces.

Mature bearing orchards

In late February or early March, turn under all old leaves and weeds with off-set or wide tandem disk. This cultivation prepares the soil for fertilizer application, reduces leaf-spot innoculum, and prepares the soil for optimum heat absorption and release for frost protection.

After bloom, cultivation with a spring-tooth harrow should be sufficient unless weed growth is rank enough to require a second disking.

The schedule of subsequent cultivations with a spring-tooth harrow will depend on conditions for weed growth. Weeds should not be allowed to develop to the extent that disking is required.

The last harrowing before fruit fall should be followed with a chain-link harrow to prepare the orchard for harvesting.

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An Economic Appraisal of

Skip-Row Cotton Planting

In the Yazoo-Mississippi Delta

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In cooperation with the Farm Production Economics Division, Economic Research Service, U. S. Department of Agriculture

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CONCLUSIONS

On better producing soils skip-row planting systems commonly used on Delta farms have an income potential greater than that of a similar amount of allotted cotton planted solid with soybeans on the remaining land, if considered in light of current cotton-soybean price relationships.

The soil resource situation on any single farm materially affects the skip-row pattern used. If sufficient acreages of suitable soils are available all cotton should be planted 2 x 2. As suitable soils become more restricted, a combination of 2 x 2 and 2 x 1 or 2 x 1 alone should be used depending on the situation.

The 4 x 4 planting system, on sandy soils, is slightly more profitable than 2 x 1 on sandy soils, but 4 x 4 requires more land to produce an acre of cotton. Since sandy soils are limited on most Delta farms 2 x 1 usually fits better into the farm organization.

Production costs associated with skip-row cotton are considerably higher than those of solid cotton.

All skip-row planting systems, other than 4 x 4, materially reduce equipment efficiency in peak demand periods. Management and equipment are under tremendous pressure during critical periods such as planting and the application of postemergence herbicides.

When yield responses of 10 to 20 per cent below the average reported for skip-row planting occur a greater farm income could be derived by planting solid cotton and soybeans, with current price relationships.

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Special appreciation is expressed to the many farmers who provided the information used to prepare this report.

An Economic Appraisal of Skip-Row Cotton Planting

By FRED T. COOKE, JR. And ARTHUR M. HEAGLER[1]

Although various forms of skip-row planting of cotton have been used for many years in the arid areas of the West, it was only in recent years that the practice was adopted in the Yazoo-Mississippi Delta. Cotton acreage allotments have made farmers in the area receptive to production techniques which offered the possibility of increased cotton yields per alloted acre. Skip-row planting has always been permissible in the area, but farmers did not use this system because the fallowed area was considered by the Agricultural Stabilization and Conservation Service (ASCS) to be a part of the cotton allotment. The first regulations permitting skip-row cotton, without counting the "skips" as part of the alloted acreage, allowed farmers to plant 4 rows of cotton and skip four rows. In 1962 the regulations were broadened to permit other skip-row patterns.

Tests conducted at the Delta Branch of the Mississippi Agricultural Experiment Station indicated that increases in yield per acre planted due to the skip-row practice could be expected. In 1962, this fact encouraged farmers in the Yazoo-Mississippi Delta to plant about 87,000 acres of cotton in various skip-row patterns. In 1963, farmers in the area planted about 206,000 acres of cotton in various skip-row patterns, and there are indications that the practice will increase.

Although the Delta Branch Experiment Station had some information on yield response to the various skip-row planting systems, no information was available on the costs or returns associated with these systems. There are also questions as to how skip-row planting would affect farm organization and net farm income. This study was an attempt to provide information to help answer these questions.

Procedure

A random sample of farms in 11 Delta counties was drawn from county ASCS files and 96 farmers were interviewed in 1962 and 183 in 1963.

Information was obtained on yields, production practices, and equipment modifications for each skip-row pattern by soil type. Four soil groupings were considered — sandy soils, loam soils, well-drained clay soils, and poorly-drained clay soils. The same information was obtained for any solid cotton produced on the farm.

Sandy soils consist of fine sandy loams, loams, and silt loams. Some of the more common soil series included in this group are Boskett silt loam, Boskett loam, Boskett fine sandy loam, Pearson silt loam, Dundee silt loam, and Dundee fine sandy loam. These soils are well drained, medium to coarse textured, lend themselves well to high levels of inputs, and are extremely well adapted to row crop production.

Loam soils are made up of silt loams, silty clay loams, and other similar soil types and include Forrestdale silt loam, Forrestdale silt clays, and Dundee silty clay loams. Usually they have poor to fair internal drainage and generally have a silt loam top soil with a clay or silt loam subsoil.

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[1] Agricultural Economics, Farm Production Economics Division, Economic Research Service, U. S. Department of Agriculture, stationed at the Delta Branch of the Mississippi Agricultural Experiment Station, Stoneville, Miss.

Well-drained clay soils consist of clay and silty clays and other soils that have similar characteristics. These soils include Sharkey Clay, Alligator Clay, and Dowling Clay. The poorly-drained clays are of these same series but the productivity is much lower because of poor drainage.

From this information, yields, costs, and returns were obtained for the skip-row systems considered and for solid planting. The systems considered were 2 x 2, 2 x 1, and 4 x 4 on sandy and loam soils, and 4x4 on clay soils.[2] Too few observations of other systems such as 4 x 2 and 4 x 1 were obtained for any valid analysis to be made. All yields, costs, and returns are reported per planted acre of cotton.

The costs and returns information obtained was used in a linear programming model to determine the most profitable cropping system for farms with different soil resources. Representative farms were set up to reflect the more common soil resource situations found on farms in the area.

It is generally believed that the ability to grow a large stalk is the principal criterion as to the suitability of a soil type for skip-row cotton. Sandy soils usually grow larger stalks capable of setting more fruit and are considered the best skip-row soils. Poorly-drained clays normally produce small stalks and thus are not well suited to skip-row cotton.

This publication reports data and analysis which can be used to appraise the economic aspects of different planting patterns under different resource situations.

Yield Response to Skip-Row Systems

The greatest yield response to any skip-row system studied in both 1962 and 1963 was 2 x 2 on sandy soils. Yield increases from 46 to 77 percent per acre planted over solid plantings were noted with the average increase for the 2 years being 53 percent. On loam soils, yield increases over solid planting ranged from 35 to 54 percent and averaged 44 percent over the 2-year period. Almost no 2 x 2 plantings were found on clay soils.

Plantings of 2 x 1 on sandy soils produced yield increases over solid plantings ranging from 21 to 49 percent and averaging 35 percent for the 2 years. Plantings of 2 x 1 on loam soils produced yields ranging from 20 to 44 percent with an average of 32 percent. Little or no 2 x 1 was found to be planted on clay soils.

Plantings of 4 x 4 on sandy soils produced yield increases over solid plantings ranging from 15 to 65 percent and averaged 34 percent. Plantings of 4 x 4 on loam soils produced yields ranging from 12 to 51 percent and averaged 32 percent for the 2 years included in the study. Forty-one observations of 4 x 4 plantings on clay soils were obtained in 1963. These 4 x 4 plantings produced yield increases ranging from 8 to 49 percent and averaged 28 percent. It should be pointed out that the range in yield response to 4 x 4 is extremely variable when compared with 2 x 2 and 2 x 1. For this reason, 4 x 4 may or may not be as desirable for the individual farmer as 2 x 1 even though the average yield increases are about the same.

The yields reported in this study are much higher than normally associated with the Yazoo-Mississippi Delta because 1963, one of the 2 years covered in this study, resulted in the highest average yields ever produced in the area. How-

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[2] For purposes of this report, plant 2, skip 2 will be referred to as 2 x 2; plant 2 skip 1 as 2x1; plant 4, skip 4 as 4x4; plant 4 skip 2 as 4x2; and plant 4, skip 1 as 4x1.

Table 1.—Estimated yields of lint, per planted acre, by planting pattern and by soils, 1962-1963 average, Yazoo-Mississippi Delta

Item	Lint yield per acre[1]	Pounds lint increase over solid	Percentage of lint increase over solid
	Pounds	Pounds	Percent
Sandy			
Solid	790	----	—
2 x 2	1,209	419	53
2 x 1	1,066	276	35
4 x 4	1,055	265	34
Loam			
Solid	710	------	
2 x 2	1,022	312	44
2 x 1	937	227	32
4 x 4	937	227	32
Clay[2]			
Solid	580	------	----
4 x 4	742	162	28

[1] Per planted acre of cotton.

[2] 1963 only.

ever, it is felt that the percentage increase in yields reported would be generally consistent for most years in the area. Table 1 presents the yields associated with the various skip-row systems by soil types.

Skip-Row Production Practices

The production of skip-row cotton requires that several production practices be modified or changed. The most obvious change in practices is that additional land must be tilled to produce an acre of cotton. This results in increased power and equipment requirements. Another problem associated with this additional land is controlling weeds in the fallowed skips. These and other changes can best be seen by looking at each skiprow pattern individually.

2 x 2. — This type of skip-row planting requires 2 acres of land to produce 1 acre of cotton. This means that seedbed preparation will have to be done on twice as much land as for solid cotton. The study indicated that most farmers used 2-row planters. Since 4-row planters would normally be used this reduces the performance rate for this operation and increases its cost. Cultivation was most commonly done with 4-row cultivators with the two outside fallowed rows being cultivated completely across the bed. Again, performance rates were reduced due to cultivation of fallowed areas. In addition to these practices, most farmers found it necessary to disk or cultivate the 2 fallowed rows an average of seven times. These operations are expensive because performance rates are low. Most chemicals for weed control were applied with 2-row applicators. Usually farmers applied no chemicals to the fallowed area.

In 1962 and 1963 an average of 11 applications of insecticides was applied to cotton on Delta farms. On 2 x 2, four of these applications were made by airplane. The cost of these applications was doubled because twice as much ground had to be covered and twice as much material was required. The cost of defoliation was doubled because most farmers used airplanes to apply the material.

2 x 1. — This skip-row pattern requires 1½ acres of land to produce an acre of cotton. Thus, 50 percent more seedbed preparation is required. Most farmers planted their 2 x 1 cotton with 2-row planters. Cultivation was done with 4-row cultivators with the fallowed rows being cultivated completely across the bed. Thus, the fallowed row was double cultivated. This means that twice as much land as actual cotton acreage was covered. Most weed-control chemicals were applied with 2-row applicators, but often the chemicals were applied to the fallowed row as well. Most farmers reported that layby chemicals were applied to the fallowed row as well as to the rows planted to cotton. Of the 11 insecticide applications applied 5 were done by airplane. The cost of these aerial applications was 50 percent greater than for solid cotton. Defoliants were applied with airplanes at a 50-percent greater cost.

4 x 4. — This skip-row pattern requires 2 acres of land for each acre of cotton. Although it is not necessary to do so, most farmers prepared a seedbed on all the land whether it was planted to cotton or not. Planting and cultivating were done with 4-row equipment and thus performance rates and costs for these operations were the same as for solid cotton. The same is true for the application of weed control chemicals. But an average of 7 cultivations with disks or field cultivators or a combination of both was used to control grass in the fallowed area. Only 2 of the 11 applications of insecticides were applied with airplanes. These 2 applications cost twice as much as applications on solid cotton.

Other Considerations. — Most farmers interviewed in the study reported that they could not plant fast enough where extensive acreages of skip-row cotton was produced. In other words, the use of 2-row planters seriously affected timeliness of this operation. One solution that has been tried by a few farmers with good results is the use of a 6-row planter with only the 4 outside hoppers actually being used. This will allow 4-row planter efficiency with almost no increase in per acre planting costs. However, most farmers tried to offset this by using more 2-row planters.

The timely and rapid application of postemergence and layby weed-control chemicals was also a problem. To overcome this obstacle two different solutions have presented themselves. The use of 6-row beams to give 4-row efficiency has resulted in some success in 2 x 2 cotton, but farmers planting 2 x 1 have not been generally satisfied with this implement. The other possibility is the purchase of used, low-horsepower tractors to supplement the tractors already on the farm. This could result in a fairly large additional investment to produce 2 x 2 or 2 x 1 cotton, but when the cost is spread over a considerable acreage for several years it becomes relatively small. The problem is that many farmers do not have additional tractor drivers available to operate these machines.

Thus, it is apparent that the number of tractors available, labor supply available, and timeliness of operations must be considered before making a decision to produce skip-row cotton.

Cost and Returns

One of the questions uppermost in the minds of farmers considering skip-row cotton is how its production costs compare with those of solid cotton and if the yield increases associated with skip-row planting are more than sufficient to pay for any increased production costs. Cost and returns budgets for solid and each skip-row system considered are found in the appendix tables. The costs included cover direct costs of production. No land rent or other costs not directly associated with production are included.

Table 2 presents the specified costs associated with each of the skip-row cotton systems, by soil type, and compare these costs with those of solid planted cotton. This table indicates specified costs are highest for 2 x 2 plantings and lowest for the 4 x 4 system. The only additional cost associated with 4 x 4 were the cost of fallowing the 4 skipped rows and 2

Table 2.—Specified costs and returns associated with solid and skip-row planted cotton by soil types, 1962-1963 average, Yazoo-Mississippi Delta

Planting systems	Costs per acre	Per acre costs above solid	Per acre returns above specified costs	Per acre returns above solid plantings
	Dollars	Dollars	Dollars	Dollars
Sand				
Solid	136.86	--------	133.75	--------
2 x 2	188.09	51.23	226.05	92.30
2 x 1	173.74	36.88	191.42	[1]57.67
4 x 4	167.36	30.50	195.05	61.30
Loam				
Solid	133.41	--------	109.80	--------
2 x 2	179.82	46.41	170.26	60.46
2 x 1	168.06	34.65	152.90	[1]43.10
4 x 4	161.97	28.56	158.99	49.19
Clay[2]				
Solid	127.43	--------	71.24	--------
4 x 4	138.97	11.54	115.19	43.95

[1] Actually 2 x 1 plantings are not directly comparable with 2 x 2 or 4 x 4 as only 50 percent as much fallowed land is required for 2 x 1. If total land is considered then returns from one-half acre of soybeans should be included in returns from 2 x 1 to make them comparable with return from 2 x 2 and 4 x 4. Thus, returns above solid plantings from 2 x 1 on sand would be increased by $20.31, or to $77.98. Added returns from soybeans on loam soils would amount to $20.78, and bring total returns to 2 x 1 on this soil to $63.88. .

[2] Well-drained clays only.

applications of insecticides by airplane. All of these skip-row costs, however, reflect the additional cost of harvesting and ginning the higher yields of cotton associated with skip-row planting.

The relatively low cost of producing 4 x 4 on well-drained clay soils were due to lack of the need for airplanes to apply insecticides or defoliants. Whereas on solid cotton, airplanes were used extensively for these purposes. Production costs for 4 x 4 grown on clay soils were $16.19 per acre. However, the difference in cost was only $11.54 per acre because $4.65 was spent on aerial applications of insecticides and defoliants. No aerial applications were made on 4 x 4 on clay soils.

Gross returns are based on average yields reported in table 1 and cotton is valued at $0.312 per pound of lint and cottonseed at $50.00 per ton. The deduction of specified costs from gross returns indicates the relative profitableness of the various planting systems. These are also presented in table 2.

As shown 2 x 2 plantings give the highest returns per acre of cotton and the highest returns of any skip-row system. As indicated 4 x 4 is slightly more profitable than 2 x 1 on sandy soils even though 2 x 1 yields are slightly higher. The lower production costs of 4 x 4 account for this. This does not mean, however, that 2 x 1 cannot compete with 4 x 4 because it takes ½ acre less land to produce an acre of cotton with 2 x 1 than with 4 x 4. Also the yield variability of 2 x 1 is much less than for 4 x 4.

Effects of Skip-Row Planting on Farm Organizations With Different Soil Resources

The analysis of individual enterprises can indicate which is more profitable, but the farmers real concern is how to organize his farm to realize the highest returns to the whole farm, not from just one enterprise. The use of the various skip-row patterns clearly points this out. Is it more profitable to plant skip-row cotton or to plant solid cotton and soybeans?

Table 3.—Yields, specified costs and returns to soybeans, by soil types with soybeans value at $2.50 per bushel[1]

Soil type	Yield	Value	Specified costs	Returns
	Bushels	Dollars	Dollars	Dollars
Sand	24	60.00	19.37	40.63
Loam	25	62.50	20.94	41.56
Well-drained clay	24	60.00	20.83	39.17
Poorly-drained clay	21	52.50	20.83	31.67

[1] Cooke, Jr., Fred T. and Heagler, Arthur M., "Factors Affecting Soybean Yields in the Delta Area of Mississippi," Miss. Agr. Expt. Sta. Bul. 630, October 1961.

To answer this question it is first necessary to determine costs and returns to the various skip-row systems by soil type as has been done. Costs and returns from soybeans must be determined in the same manner. The latter information is quoted from a study done at the Delta Branch Experiment Station in 1961.[3] Table 3 shows the yields, specified costs and returns to soybeans on the four soil type used. A price of $2.50 per bushel was used for soybeans because these are somewhat indicative of current prices and compare with the prices used for cotton. It was felt that if skip-row systems for cotton could compete successfully with soybeans at this price there woud be no question as to the profitableness of these systems.

Linear programming was used to determine the most profitable organization for 6 farms with different mixes of soil resources. The soil resources appearing on these farms are the same four discussed in a previous section of this report. Table 4 presents the soil resources of these sample farms.

Farm 1. — This farm has a high percentage of sandy soils which are used for skip-row planting of cotton.[4] There is sufficient acreage of sandy soil to plant the entire cotton allotment using the 2 x 2 system and this proved to be the most profitable solution. This system required 578 acres of sandy soil. The remainder of the sandy soils and all other land was planted to soybeans.

Farm 2. — Sixty-five percent of the land on this farm was suitable for skip-row cotton but inadequate acreage for the entire allotment to be planted as 2 x 2. As a result, the most profitable organization has all the sand planted in 2 x 1 and all the loam but 78 acres is planted 2 x 1. The 78 acres of loam are planted in 2 x 2 to complete the cotton acreage and all clay is planted in soybeans. It should be noted that the 2 x 2 is planted on loam soil and not sandy soil. This is because the returns to 2 x 1 on sand are higher than for 2 x 2 on loam (table 2). With this organization returns are maximized.

Farm 3. — The most profitable orgaization for this farm has 2 x 1 planted on all the sand and loam soils and 35 acres of solid cotton on well-drained clay soils. Only 49 percent of the land on this unit is suitable for skip-row cotton. All other land is in soybeans.

Farm 4. — This sample farm has a small amount of sand and loam soils. The most profitable organization for this farm has all the sand and loam soil in 2 x 1. Ninety-four acres of cotton on well-drained clay soils are planted 4 x 4. There are also 110 acres of solid cotton on well-drained clay soils. The optimum solution used all the land possible for skip-row planting and still left enough of the most productive land to plant the remainder of the cotton allotment as solid cotton.

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[3] Cooke, Jr., Fred T. and Heagler, Arthur M., "Factors Affecting Soybean Yields in the Delta Area of Mississippi," Miss. Agr. Expt. Sta. Bul. 630, October 1961.

[4] As was pointed out earlier, soils suitable for skip-row planting are those which have the capability of growing a large stalk in most years.

Farm 5. — Only 35 percent of the soils on this farm are suited for any type of skip-row cotton. Sixteen acres of cotton were planted as 2 x 1 on sandy soil and the remainder of the cotton was planted solid on sand, loam, and well-drained clay soils. The 2 x 1 cotton would probably not be planted on this farm because the acreage is not large enough to justify adapting machinery for it even though this small acreage of 2 x 1 does add to total farm income.

Farm 6. This sample farm is included to show that it does not pay to plant skip-row cotton if it means that some part of the cotton allotment has to be planted on poor quality land. There is only enough sand and loam soils to plant the cotton allotment and the remainder of the land is poorly-drained clay. The most profitabe organization for this farm has solid cotton on sand and loam soils and soybeans on the clay soils.

Effect of Yield Differences On Choice Of Planting Pattern

Yield variations among production years are normally expected. However, considerable variation in skip-row yields within each year was noted among all skip-row systems and on a soil types. Yields associated with all skip-row planting systems were reduced 10 and 20 percent from those reported in table 5, and costs and returns data developed for each production level (tables 6 and 7). Solid planted yields were not changed. This information was used in a linear programming model to evaluate the effect of reduced skip-row yields in the optimum organization associated with each of the 6 sample farm resource situations.

The results indicate that the optimum organization in every resource situation is materially altered when skip-row yields

Table 4.—Total acreage and percentages of each soil type for the 6 sample farms analyzed

Item	Farm number					
	1	2	3	4	5	6
Sand						
Acres	638	298	255	42	42	145
Percent	75	35	30	5	5	17
Loam						
Acres	85	155	126	85	85	144
Percent	10	18	15	10	10	17
Well-drained clay						
Acres	42	100	35	298	170	0
Percent	5	12	4	35	20	0
Poorly-drained clay						
Acres	85	297	434	425	553	561
Percent	10	35	51	50	65	66
Total cropland—acres	850	850	850	850	850	850
Total cotton allotment — acres	289	289	289	289	289	289
Land suitable for skip-row						
Acres	775	553	416	425	297	289
Percent	90	65	49	50	35	34

Table 5.—Average cotton yields per planted acre of cotton, for solid plantings, and average and varying yields for skip-row plantings

Item	Average yield	10 percent reduction in yield	20 percent reduction in yiel
	Pounds	Pounds	Pounds
Sand			
Solid	790	-------	----
2 x 2	1,209	1,088	967
2 x 1	1,066	959	853
4 x 4	1,058	952	846
Mixed			
Solid	710	-------	------
2 x 2	1,022	920	818
2 x 1	937	843	750
4 x 4	937	843	750
Clay			
Solid	580	-------	----
4 x 4	742	668	594

Table 6.—Costs and returns, per planted acre of cotton, by soil type, with average solid planted yields, and skip-row yields reduced 10 percent

Item	Cost per acre	Per acre cost over solid	Per acre returns over specified costs	Per acre returns over solid
	Dollars	Dollars	Dollars	Dollars
Sand				
Solid	136.86	------	133.75	-------
2 x 2	182.79	45.93	189.90	56.15
2 x 1	169.04	32.18	159.48	[1]25.73
4 x 4	162.65	25.79	163.44	29.69
Mixed				
Solid	133.41		109.80	--------
2 x 2	175.36	41.95	139.79	29.99
2 x 1	164.01	30.60	124.77	[1]14.97
4 x 4	157.92	24.51	130.86	21.06
Clay				
Solid	127.43		71.22	-------
4 x 4	135.80	8.37	93.04	21.82

[1] See footnote 2, table 2.

are reduced 20 percent. Solid cotton replaces all skip-row patterns utilizing the best cotton soils until the allotment is exhausted.

Generally, a 10-percent reduction in skip-row yields affected the farm organizations in the same manner as 20-percent reduction. However, the optimum organizations for farms 1 and 6 were not affected by the yield reduction.

Farm income decreased on all the sample farms except farm 6. The optimum organization for this farm contained no skip-row cotton; thus, neither income level nor crop organization were affected by skip-row variations. As would be expected income loss was greater on farms with the largest skip-row potential and nonexistent on farms with no skip-row potential.

Table 7.—Costs and returns per planted acre of cotton, by soil type, with average solid planted yields, and skip-row yields reduced 27 percent

Item	Cost per acre	Per acre cost over solid	Per acre returns over specified costs	Per acre returns over solid
	Dollars	Dollars	Dollars	Dollars
Sand				
Solid	136.86	--------	133.75	--------
2 x 2	177.40	40.54	153.85	20.10
2 x 1	164.45	27.59	127.74	[1]—6.01
4 x 4	158.00	21.14	131.79	—1.96
Mixed				
Solid	133.41	--------	109.80	--------
2 x 2	170.94	37.53	109.28	—.52
2 x 1	159.90	26.49	97.00	[1]—12.80
4 x 4	153.81	20.40	103.09	—6.71
Clay				
Solid	127.43	--------	71.22	--------
4 x 4	132.53	5.10	70.94	—.28

[1] See footnote 2, table 2.

APPENDIX

Appendix Table 1.—Gross income and specified costs and returns for producing 1 acre of solid cotton on sandy soils, Yazoo-Mississippi Delta, 1962-63

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	158	.312	49.30
Machine picked	lb.	632	.295	186.44
Cottonseed	lb.	1,395	.025	34.87
Total	lb.			270.61
Expenses:				
Seed[1]	cwt.	.3	9.00	2.70
Fertilizer (NH_3)	cwt.	1.0	6.10	6.10
Insecticide	acre	1.0	9.04	9.04
Insecticide application	acre	1.0	3.12	3.12
Herbicide[1]	acre	1.0	4.10	4.10
Defoliant	acre	1.0	1.27	1.27
Defoliant application	acre	1.0	1.25	1.25
Tractor operation	hour	6.59	2.00	13.18
Equipment operation[2]	acre	1.0		39.26
Ginning, bagging and ties	cwt.-lint	7.90	2.70	21.33
Interest on operating capital	acre	------	------	2.95
Miscellaneous	acre	------	------	1.00
Labor—chopping and picking	------	------	------	23.37
Other labor	------	------	------	8.19
Total	------	------	------	136.86
Returns above specified costs	------	------	------	133.75

[1] One-third acre replanted and preemerged.

[2] Includes ground insecticide application.

Appendix Table 2.—Gross income and specified costs and returns for producing 1 acre of 2 x 2 cotton on sandy soils, Yazoo-Mississippi Delta, 1962-63[1]

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	242	.312	75.50
Machine picked	lb.	967	.295	285.27
Cottonseed	lb.	2,135	.025	53.37
Total	lb.	------	------	414.14
Expenses:				
Seed[2]	cwt.	.3	9.00	2.70
Fertilizer	cwt.	1.0	6.10	6.10
Insecticide	acre	1.0	12.33	12.33
Insecticide application	acre	1.0	6.80	6.80
Herbicide[2]	acre	1.0	4.77	4.77
Defoliant	acre	2.0	1.30	2.60
Defoliant application	acre	2.0	1.17	2.34
Tractor operation	hour	12.36	2.00	24.72
Equipment operation[3]	acre	1.0	45.60	45.60
Ginning, bagging and ties	cwt.-lint	12.09	2.70	32.64
Interest on operating capital	acre	------	------	3.93
Miscellaneous	acre	------	------	1.00
Labor—chopping and picking	------	------	------	30.49
Other labor	------	------	------	12.07
Total	------	------	------	188.09
Returns above specified costs	------	------	------	226.05

[1] One acre of cotton and 2 acres of land.

[2] One-third acre replanted and preemerged.

[3] Includes ground insecticide application.

Appendix Table 3.—Gross income and specified costs and returns for producing 1 acre of 2 x 1 cotton on sandy soils, Yazoo-Mississippi Delta, 1962-63[1]

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	213	.312	66.46
Machine picked	lb.	853	.295	251.63
Cottonseed	lb.	1,883	.025	47.07
Total	lb.			365.16
Expenses:				
Seed[2]	cwt.	.3	9.00	2.70
Fertilizer	cwt.	1.0	6.10	6.10
Insecticide	acre	1.0	11.09	11.09
Insecticide application	acre	1.5	3.80	5.70
Herbicide[2]	acre	1.0	10.33	10.33
Defoliant	acre	1.5	1.27	1.90
Defoliant application	acre	1.5	1.25	1.87
Tractor operation	hour	9.63	2.00	19.26
Equipment operation[3]	acre	1.5		41.92
Ginning, bagging and ties	cwt.-lint	10.66	2.70	28.78
Interest on operating capital	acre	------	------	3.70
Labor—chopping and picking	------	------	------	29.01
Other labor	------	------	------	10.38
Total	------	------	------	173.74
Returns above specified costs	------	------	------	191.42

[1] One acre of cotton and 1½ acres of land.

[2] One-third acre replanted and preemerged.

[3] Includes ground insecticide application.

Appendix Table 4.—Gross income and specified costs and returns for producing 1 acre of 4 x 4 cotton on sandy soils, Yazoo-Mississippi Delta, 1962-63[1]

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	212	.312	66.14
Machine picked	lb.	846	.295	249.57
Cottonseed	lb.	1,868	.025	46.70
Total	lb.	------	------	362.41
Expenses:				
Seed[2]	cwt.	.3	9.00	2.70
Fertilizer	cwt.	1.0	6.10	6.10
Insecticide	acre	1.0	10.68	10.68
Insecticide application	acre	2.0	1.56	3.12
Herbicide[2]	acre	1.0	3.36	3.36
Defoliant	acre	2.0	1.27	2.54
Defoliant application	acre	2.0	1.25	2.50
Tractor operation	hour	10.73	2.00	21.46
Equipment operation[3]	acre	1.0	44.10	44.10
Ginning, bagging and ties	cwt.-lint	10.58	2.70	28.57
Interest on operating capital	acre	------	------	3.52
Miscellaneous	acre	------	------	1.00
Labor—chopping and picking	------	------	------	27.07
Other labor	------	------	------	10.64
Total	------	------	------	167.36
Returns above specified costs	------	---	------	195.05

[1] One acre of cotton and 2 acres of land.

[2] One-third acre replanted and preemerged.

[3] Includes ground insecticide application.

Appendix Table 5.—Gross income and specified costs and returns for producing 1 acre of solid cotton on loam soils, Yazoo-Mississippi Delta, 1962-63

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	142	.312	44.30
Machine picked	lb.	568	.295	167.56
Cottonseed	lb.	1,254	.025	31.35
Total	lb.	------	------	243.21
Expenses:				
Seed[1]	cwt.	.3	9.00	2.70
Fertilizer (NH_3)	cwt.	1.0	6.10	6.10
Insecticide	acre	1.0	9.04	9.04
Insecticide application	acre	1.0	3.12	3.12
Herbicide[1]	acre	1.0	4.10	4.10
Defoliant	acre	1.0	1.27	1.27
Defoliant application	acre	1.0	1.25	1.25
Tractor operation	hour	6.59	2.00	13.18
Equipment operation[2]	acre	1.0	[illegible]	39.26
Ginning, bagging and ties	cwt.-lint	7.1	2.70	19.17
Interest on operating capital	acre	------	------	2.95
Miscellaneous	acre	------	------	1.00
Labor—chopping and picking	------	------	------	22.08
Other labor	------	------	------	8.19
Total	------	------	------	133.41
Returns above specified costs	------		------	109.80

[1] One-third acre replanted and preemerged.

[2] Includes ground insecticide application.

Appendix Table 6.—Gross income and specified costs and returns for producing 1 acre of 2 x 2 cotton on loam soils, Yazoo-Mississippi Delta, 1962-63[1]

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	204	.312	63.65
Machine picked	lb.	818	.295	241.31
Cottonseed	lb.	1,805	.025	45.12
Total	lb.	-----	-----	350.08
Expenses:				
Seed[2]	cwt.	.3	9.00	2.70
Fertilizer	cwt.	1.0	6.10	6.10
Insecticide	acre	1.0	12.33	12.33
Insecticide application	acre	1.0	6.80	6.80
Herbicide[2]	acre	1.0	4.77	4.77
Defoliant	acre	2.0	1.30	2.60
Defoliant application	acre	2.0	1.17	2.34
Tractor operation	hour	12.36	2.00	24.72
Equipment operation[3]	acre	1.0	45.60	45.60
Ginning, bagging and ties	cwt.-lint	10.22	2.70	27.59
Interest on operating capital	acre	-----	-----	3.93
Miscellaneous	acre	-----	-----	1.00
Labor—chopping and picking	-----	-----	-----	27.27
Other labor	-----	-----	-----	12.07
Total	-----	-----	-----	179.82
Returns above specified costs	-----	-----	-----	170.26

[1] One acre of cotton and 2 acres of land.

[2] One-third acre replanted and preemerged.

[3] Includes ground insecticide application.

Appendix Table 7.—Gross income and specified costs and returns for producing 1 acre of 2 x 1 cotton on loam soils, Yazoo-Mississippi Delta, 1962-63[1]

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	187	.312	58.34
Machine picked	lb.	750	.295	221.25
Cottonseed	lb.	1,655	.025	41.37
Total	lb.	-----	-----	320.96
Expenses:				
Seed[2]	cwt.	.3	9.00	2.70
Fertilizer	cwt.	1.0	6.10	6.10
Insecticide	acre	1.0	11.09	11.09
Insecticide application	acre	1.5	3.80	5.70
Herbicide[2]	acre	1.0	10.33	10.33
Defoliant	acre	1.5	1.27	1.90
Defoliant application	acre	1.5	1.25	1.87
Tractor operation	hour	9.63	2.00	19.26
Equipment operation[3]	acre	1.5		41.92
Ginning, bagging and ties	cwt.-lint	9.37	2.70	25.30
Interest on operating capital	acre	-----	-----	3.70
Miscellaneous	acre	-----	-----	1.00
Labor—chopping and picking	-----	-----	-----	26.81
Other labor	-----	-----	-----	10.38
Total	-----	-----	-----	168.06
Returns above specified costs	-----	-----	-----	152.90

[1] One acre of cotton and 1½ acres of land.

[2] One-third acre replanted and preemerged.

[3] Includes ground insecticide application.

Appendix Table 8.—Gross income and specified costs and returns for producing 1 acre of 4 x 4 cotton on loam soils, Yazoo-Mississippi Delta, 1962-63[1]

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	187	.312	58.34
Machine picked	lb.	750	.295	221.25
Cottonseed	lb.	1,655	.025	41.37
Total	lb.	------	------	320.96
Expenses:				
Seed[2]	cwt.	.3	9.00	2.70
Fertilizer	cwt.	1.0	6.10	6.10
Insecticide	acre	1.0	10.68	10.68
Insecticide application	acre	2.0	1.56	3.12
Herbicide[2]	acre	1.0	3.36	3.36
Defoliant	acre	2.0	1.27	2.54
Defoliant application	acre	2.0	1.25	2.50
Tractor operation	hour	10.73	2.00	21.46
Equipment operation[3]	acre	1.0	44.10	44.10
Ginning, bagging and ties	cwt.-lint	9.37	2.70	25.30
Interest on operating capital	acre	------	------	3.52
Miscellaneous	acre	------	------	1.00
Labor—chopping and picking	------	------	------	24.95
Other labor	------	------	------	10.64
Total	------	------	------	161.97
Returns above specified costs	------	------	------	158.99

[1] One acre of cotton and 2 acres of land.
[2] One-third acre replanted and preemerged.
[3] Includes ground insecticide application.

Appendix Table 9.—Gross income and specified costs and returns for producing 1 acre of solid cotton on well-drained clay soils, Yazoo-Mississippi Delta, 1962-63

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	116	.312	36.19
Machine picked	lb.	464	.295	136.88
Cottonseed	lb.	1,024	.025	25.60
Total	lb.	------	------	198.67
Expenses:				
Seed[1]	cwt.	.3	9.00	2.70
Fertilizer	cwt.	3.0	3.80	11.40
Insecticide	acre	1.0	9.04	9.04
Insecticide application	acre	1.0	3.40	3.40
Herbicide[1]	acre	1.0	2.74	2.74
Defoliant	acre	1.0	1.27	1.27
Defoliant application	acre	1.0	1.25	1.25
Tractor operation	hour	5.16	2.00	10.32
Equipment operation[2]	acre	1.0	38.49	38.49
Ginning, bagging and ties	cwt.-lint	5.8	2.70	15.66
Interest on operating capital	acre	------	------	2.95
Miscellaneous	acre	------	------	1.00
Labor—chopping and picking	------	------	------	19.81
Other labor	------	------	------	7.40
Total	------	------	------	127.43
Returns above specified costs	------		------	71.24

[1] One-third acre replanted and preemerged.
[2] Includes ground insecticide application.

Appendix Table 10.—Gross income and specified costs and returns for producing 1 acre of 4 x 4 cotton on well-drained clay soils, Yazoo-Mississippi Delta, 1962-63[1]

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	148	.312	46.18
Machine picked	lb.	594	.295	175.23
Cottonseed	lb.	1,310	.025	32.75
Total	lb.	-----	------	254.16
Expenses:				
Seed[2]	cwt.	.3	9.00	2.70
Fertilizer	cwt.	3.0	3.80	11.40
Insecticide	acre	1.0	9.04	9.04
Herbicide[2]	acre	1.0	2.74	2.74
Defoliant	acre	1.0	1.27	1.27
Tractor operation	hour	7.73	2.00	15.46
Equipment operation[3]	acre	1.0	--	42.53
Ginning, bagging and ties	cwt.-lint	7.42	2.70	20.03
Interest on operating capital	acre	1.0		3.06
Miscellaneous	acre	1.0	--	1.00
Labor—chopping and picking		-	- - -	20.51
Other labor	------	---	----	9.23
Total	----	---	--- --	138.97
Returns above specified costs		--	--	115.19

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[1] One acre of cotton and 2 acres of land.
[2] One-third acre replanted and preemerged.
[3] Includes ground insecticide application.

Appendix Table 11.—Gross income and specified costs and returns for producing 1 acre of solid cotton on poorly-drained clay soils, Yazoo-Mississsppi Delta, 1962-63

Item	Unit	Quantity	Price	Amount
		Number	Dollars	Dollars
Income:				
Cotton lint				
Handpicked	lb.	101	.312	31.51
Machine picked	lb.	404	.295	119.18
Cottonseed	lb.	892	.025	22.30
Total	lb.	----	----	172.99
Expenses:				
Seed[1]	cwt.	.3	9.00	2.70
Fertilizer	cwt.	3.0	3.80	11.40
Insecticide	acre	1.0	9.04	9.04
Insecticide application	acre	1.0	3.40	3.40
Herbicide[1]	acre	1.0	2.74	2.74
Defoliant	acre	1.0	1.27	1.27
Defoliant application	acre	1.0	1.25	1.25
Tractor operation	hour	5.16	2.00	10.32
Equipment operation[2]	acre	1.0	38.49	38.49
Ginning, bagging and ties	cwt.-lint	5.05	2.70	13.63
Interest on operating capital	acre		-- - -	2.95
Miscellaneous	acre	--- --	-- - -	1.00
Labor—chopping and picking	---	- --	- -	18.55
Other labor	- -	--	------	7.40
Total		- - -	-- -	124.14
Returns above specified costs			----	48.85

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[1] One-third acre replanted and preemerged.
[2] Includes ground insecticide application.

BULLETIN 698 DECEMBER 1964

Interplanted

Legumes In Johnsongrass

By HUGH W. BENNETT AND
N. C. MERWINE

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in cooperation with
Crops Research Division
Agricultural Research Service
United States Department of Agriculture

Conclusions

All fertilizer and interplanted legume treatments increased the yields of Johnsongrass. Yields were significantly increased the first year by interplanted roughpea and by roughpea, black medic, and Persian clover the second year. It is most likely that the other legumes would follow the same pattern in a year or more when they became more strongly established.

Increases in yield of Johnsongrass due to potash were negligible and yields the second year were practically the same as the first year.

The application of 32 pounds of nitrogen increased the yield of Johnsongrass approximately 36 percent, and this increase was constant for the two years.

The three rates of phosphorus applied alone or in combination increased yields the second year. The yield following phosphorus alone the second year was the same as that from nitrogen alone. All fertilizer treatments containing phosphorus gave significant responses, and the responses increased the second year over the first.

Use of phosphorus with nitrogen increased the efficiency of nitrogen in the production of Johnsongrass. This increase was greater (15 percent) when used with an interplanted legume.

The addition of phosphorus increased the yields of Johnsongrass due to the increased growth of interplanted legumes.

The calcium content of the legumes was not altered by the addition of fertilizers.

The average phosphorus content of the legumes was increased 30 percent by applications of phosphate alone or in combination with nitrogen or potash, or with both.

The crude protein of the legumes was increased by nitrogen and phosphate.

The phosphorus content of Johnsongrass was increased by application of fertilizers. This increase was greater following interplanted legumes.

The crude protein content of Johnsongrass was increased by fertilizer. This increase was due to applications of nitrogen alone or in combination with other fertilizers. The increases were greater with interplanted legumes. This emphasizes the importance of higher rates of fertilization with Johnsongrass.

INTERPLANTED LEGUMES IN JOHNSONGRASS

By HUGH W. BENNETT and N. C. MERWINE[1]

Lower production costs and increased efficiency are no less important to agriculture than to other types of industry. Efficiency in most Mississippi livestock enterprises is directly related to production of homegrown feeds. Pasture provides the cheapest and best source of nutrients but stored forage is necessary for adequate year-round feeding programs.

Johnsongrass, **Sorghum halepense (L.) pers.,** was introduced into the "Black" or "Prairie" Belt of Mississippi and Alabama some 130 years ago as a forage plant of superior value. It is so well adapted to the well-drained lime soils that, intentionally or unintentionally, it became prevalent over all the area. For many years, it was utilized mainly as a hay crop. The growth of the livestock industry in this area has resulted in Johnsongrass being used to good advantage in a system of year-round grazing and silage, as well as for hay.

The interplanting of legumes in Johnsongrass has been recommended, and used to some degree, to develop more uniform seasonal production. The grazing season could be lengthened by growing a winter or early spring crop which would make its growth before Johnsongrass came into its heaviest production. This would permit a more uniform stocking rate for pastures on a yearly basis, reduce the necessity of buying or selling on unfavorable livestock markets to maintain a proper pasture grazing load, and enable the operator to preserve quality hay or silage during peaks of production.

It is the purpose of this bulletin to present the effects of associated legumes, with and without fertilizer, on the production of Johnsongrass.

Materials and Methods

An experiment was conducted on first-year established Johnsongrass to determine the effects of interplanted legumes under annual applications of various amounts of fertilization.

Six legume treatments were used, namely; no legume, black medic (**Medicago lupulina** L.), Roughpea (**Lathyrus hirsutus,**L.), Persian clover (**Trifolium resupinatum** L.), white clover (**Trifolium repens** L.), and low hop clover (**Trifolium procumbens** L.). Roughpea is commonly known as wild winter pea in Mississippi, as Caley pea in Alabama, and Singletary pea in Louisiana.

Fifteen fertilizer treatments consisted of the following: 32 pounds of N; 30, 60, and 90 pounds of P_2O_5; and 50 pounds of K_2O per acre—either alone or in combination. The combination of nitrogen and potassium was omitted because previous work showed that this soil did not respond to potash. The mineral fertilizers were applied each fall before legume growth began, and the nitrogen treatments in early summer and after the legumes were clipped.

The various legume and fertilizer treatments were replicated 8 times in a randomized split plot design on a shallow phase of Sumter clay soil. The le-

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[1] Agent, Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture and Agronomist, Mississippi Agr. Exp. Sta. respectively.

Table 1. Yields of Johnsongrass following various interplanted legumes. Average of all fertilizer treatments.

Legume	First year Harvest 1st	First year Harvest 2nd	Second year Harvest 1st	Second year Harvest 2nd
	Pounds green weight per acre			
Black Medic	7143	14846	5879**	22529
Roughpea	7111	18039	5949**	26016
Persian clover	6065	15509	4744	19643
White clover	5913	13035	5135	17088
Low hop clover	5738	15400	4093	16280
No legume	5981	15556	4397	16035
LSD				
05	1298	1520	808	3047
01	1743	2040	1105	4089

gumes were clipped at the flowering stage and removed from the plots. The Johnsongrass was clipped twice each year, once in late May or early June and again in late August or early September. Chemical analyses were made on samples composited from each replication. Duplicate analyses were made on samples from each treatment or combination of treatments.

The soil was a high lime (pH 8) shallow clay from chalk 20-25 inches deep. This soil is generally well supplied with potash and fairly well with phosphorus. The high lime content often ties up phosphorus to cause a deficiency. This is a common limestone prairie soil, generally unsuited to row crops, but recommended for pasture and hay crops. Corn yields, with no fertilization on this area had averaged 8 bushels per acre for a 4-year period prior to the test.

Experimental Results

Highly significant differences in total yields of Johnsongrass were found among fertilizers and legumes. Interaction between fertilizers and legumes was not significant, and the data were analyzed separately for fertilizers and legumes.

In the first year of the test, there were no significant differences in yields of Johnsongrass for the first harvest among the legumes. Two highly significant differences were found in the second harvest. The yield of Johnsongrass following roughpea was higher at the 1 percent level than that following no legume while a significantly lower (1 percent level) yield was obtained following white clover. Second year first harvest yields were significantly higher following roughpeas and black medic than following Persian clover. These data are given in table 1.

A combination of factors may help to explain the above results. White clover is a low-growing, dense plant which offered more competition to the establishment of Johnsongrass in the first year. This delayed the strong establishment until the second year when the grass yield was slightly higher, than the yield following no legume. White clover is the only legume used in the test that continued to grow past the spring season. This added competition to Johnsongrass establishment before the clover was producing an appreciable amount of nodules for decomposition. Roughpeas are well adapted to this eroded soil and consistently produced higher yields than the other legumes used. This would indicate a greater amount of root material left in the soil to decompose and furnish nitrogen for the grass crop. Availability of nitrogen from nodules of the two crops also may have been a factor.

Since the test was conducted only two years, and Persian clover showed significant increases the second year, it seems likely that the other legumes would follow the same pattern when they became more strongly established.

Several significant differences were found among the fertilizer treatments. The first harvest of the first year showed no differences among fertilizer treatments, but highly significant increases occurred in all other harvests where fertilizer had been used. (Table 2.)

No response was obtained from the application of 50 pounds of K_2O per acre when applied alone. Applications of K_2O in combination with phosphorus or phosphorus plus nitrogen gave significantly higher yields than where potash was applied alone or where no fertilizer was used. These combinations with potash, however, produced no significantly higher yields than the combinations without potash.

Nitrogen, alone or in combination with phosphorus, produced highly significant increases in the yield of Johnsongrass. The second harvest of the first year showed a trend of increase due to application of phosphorus with nitrogen. In the second year, both harvests gave highly significant increases for all fertilizer applications containing nitrogen. Nitrogen and phosphorus in combination gave higher yields (approximately twice that of either nitrogen or phosphorus alone) than the application of nitrogen alone. Thirty-two pounds of nitrogen applied when legumes were removed produced approximately the same increase whether applied alone or in combination with phosphorus. This amount was approximately 8,000 pounds of green weight per acre and represents 9 to 10 pounds of nitrogen as determined from composited forage analyses.

Phosphorus alone did not show any significant difference in yield over no fertilizer in the first year. Highly significant increases over check were obtained from the second application of all three rates of phosphorus. It will also be noted that highly significant increases over check were obtained in the second cutting the first year, where all rates of phosphorus were combined with nitrogen

Table 2. Yield of Johnsongrass with various applications of fertilizer. Average of yields following all interplanted legumes.

Fertilizer Lbs. N	Per P_2O	Acre K_2O	First year Harvest 1st	2nd	Second year Harvest 1st	2nd	Average Harvest 1st	2nd
			Pounds green weight per acre					
0	0	0	6364	11,327	3403	14,169	4884	12,748
32	0	0	6069	18,457	4634	18,735	5352	18,596
0	30	0	5405	10,425	4129	17,402	4767	13,914
0	60	0	7033	11,191	4333	18,604	5683	14,898
0	90	0	6426	11,213	4663	19,750	5545	15,482
0	0	50	5400	12,337	3460	14,140	4430	13,238
32	30	0	6761	20,107	5774	22,410	6268	21,258
32	60	0	6727	18,882	6234	23,505	6530	21,194
32	90	0	5939	19,132	6165	22,668	6052	20,900
0	30	50	6523	11,094	4566	16,914	5550	14,004
0	60	50	6012	13,193	4447	18,672	5230	15,933
0	90	50	6693	16,233*	4940	19,024	5817	17,629
32	30	50	6500	17,912**	5893	21,361	6197	19,637
32	60	50	6614	19,608**	6608*	23,573	6611	21,591
32	90	50	6404	19,829**	6239	22,306	6322	21,068
LSD								
05			987	4203	669	2343		
01			1305	5564	891	3171		

Table 3. Average yield of Johnsongrass with various applications and combinations of fertilizers. Averages of yields following all interplanted legumes.

	First year Harvest			Second year Harvest			Average Harvest		
Fertilizer[1]	1st	2nd	Total	1st	2nd	Total	1st	2nd	Total
			Pounds green weight per acre						
0	6364	11327	17691	3403	14169	17572	4884	12748	17632
N	6069	18457	24526	4634	18735	23369	5352	18596	23948
P	6288	10943	17231	4375	18585	22960	5298	14765	20096
K	5400	12337	17737	3460	14140	17600	4430	13238	17668
NP	6476	19374	25850	6091	22861	28952	6283	21117	27600
PK	6409	13507	19916	4651	18203	22854	5532	15855	21387
PKN	6506	19116	25622	6247	22413	28660	6377	20765	27142

[1] N=32 lbs. K=50 lbs K_2O; P=average of 30, 60, and 90 lbs. of P_205 per acre.

or potash.

Table 3 shows the average yield of Johnsongrass with the various applications and combinations (three rates of phosphorus averaged alone and in combination) of fertilizers. Green weight yields in pounds per acre are averages of yields following all interplanted legumes. These data show that the yields from plots receiving no fertilizer treatment and those receiving 50 pounds of K_2O per acre were relatively constant for both years, and both were the same. There was considerable increase in yield due to the application of 32 pounds of N per acre over that of no treatment, but this increased yield also remained constant for both years. Application of the three rates of phosphorus alone or in combination gave increasing yields the second year over the first year. The combination of the three rates of phosphorus with nitrogen and potash increased yields the second year, but they were approximately the same as the combination of phosphorus and nitrogen without potash. All treatments containing phosphorus gave significant responses the second year. This would eliminate the possibility of a more favorable growing season in the second year as cause for the increase. Thirty pounds of P_2O_5 applied each year produced a yield comparable to 90 pounds the first year. It appears that 60 pounds of P_2O_5 applied annually, alone or in combination with nitrogen, would give the most economical increase.

The acre increase in yield of Johnsongrass due to applications of fertilizer is shown in table 4. These increases are averages of the yields following all interplanted legumes. It should be pointed out that the trend in the first year is to show response only to nitrogen, and almost all of this increase was in the second cutting. The yield following phosphorus alone during the second year was approximately the same as that from nitrogen alone. It should be emphasized that the addition of phosphorus to nitrogen gave twice the increase in yield as either applied alone. Also, the yield of the second year was increasing, while the yield from treatments receiving nitrogen alone remained the same. The yield from treatments receiving potash alone were not increased over those obtained from the no fertilizer treatments. Addition of phosphorus to the potash gave increases in Johnsongrass yields. Much of this increase can be attributed to the effects of the increased growth of the interplanted legumes.

It is apparent (Table 5) that the yields of all the legumes were increased by applications of phosphorus, whether alone or in combination with nitrogen or potash, or with both. The application of potash with phosphorus gave no increase in legume growth over that obtained with

Table 4. Pounds per acre and percent increase in the yield of Johnsongrass over no treatment due to the application of fertilizers alone and in combination. Green weight averages following all interplanted legumes.

	First year Harvest			Second year Harvest			Average Harvest		
Fertilizer[1]	1st	2nd	Total	1st	2nd	Total	1st	2nd	Total
None	6364	11327	17691	3403	14169	17572	4884	12748	17632
N									
pounds increase	—295	7130	6835	1231	4566	5797	468	5848	6316
percent increase	—4.6	63.0	38.6	36.2	32.2	34.1	9.6	45.9	35.8
P									
pounds increase	—76	—384	—460	972	4416	5388	414	2017	2464
percent increase	—1.2	—3.5	—2.7	28.6	31.2	30.7	8.5	15.8	14.0
K									
pounds increase	—964	1010	46	57	29	28	54	490	36
percent increase	—15.2	8.9	0.2	1.7	0.2	1.6	1.1	3.8	0.2
NP									
pounds increase	112	8947	8159	2688	8692	11380	1399	8369	9968
percent increase	1.8	71.0	46.1	79.0	61.3	64.8	28.7	64.7	56.5
PK									
pounds increase	45	2180	2225	1248	4034	5282	648	3107	3755
percent increase	0.7	19.3	12.6	36.7	28.5	30.1	13.3	24.4	21.3
PKN									
pounds increase	142	7789	7931	2844	8244	11088	1493	8017	9510
percent increase	2.2	68.8	44.8	83.6	58.2	63.1	30.6	62.9	53.9

[1] See footnote 1, table 3.

Table 5. Two-year average yield of interplanted legumes. Eight replications.

Fertilizer Lbs. Per Acre N	P_2O_5	K_2O	Black medic	Roughpea	Legume Persian clover	White clover	Low hop clover	Average All legumes
					Pounds of green weight per acre			
0	0	0	5119	6466	4180	4452	2586	4561
32	0	0	4805	6317	4765	4261	3362	4702
0	30	0	6221	7528	7937	6875	4860	6684
0	60	0	5594	8809	6670	6807	3989	6609
0	90	0	6126	8577	8944	5410	4900	6791
0	0	50	3771	5350	4180	3675	2627	3921
32	30	0	5854	5894	6848	6508	2818	5584
32	60	0	5500	9420	5540	6262	5078	6360
32	90	0	6902	7937	6262	5473	5677	6450
0	30	50	5309	7787	5364	4696	3770	5385
0	60	50	6398	9284	6630	5881	5582	6755
0	90	50	5268	8890	6085	5078	3812	5827
32	30	50	5309	7420	5813	3580	5037	5432
32	60	50	6630	9489	6984	5540	3989	6526
32	90	50	5486	10006	6766	5813	4942	6603

Table 6. Two-year average yields of interplanted legume yields. Total average of 3 rates of phosphorus alone and in combination with nitrogen and potash.

Fertilizer[1]	Black medic	Roughpea	Persian clover	White clover	Low hop clover	Average all legumes
			Pounds green weight per acre			
None	5119	6466	4180	4452	2586	4561
N	4805	6317	4765	4261	3362	4702
P	5980	8271	7850	6362	4583	6609
K	3771	5350	4180	3675	2627	3921
NP	6081	7750	6217	6081	4583	6143
PK	5658	8654	6026	5218	4388	5981
PKN	5808	8622	6520	4978	4814	6160
Average all fertilizer	5351	7696	5926	5096	4060	5586
Average all fertilizer with phosphorus	5880	8324	6653	5660	4592	6226

[1] Footnote 1, Table 3.

phosphorus alone except in the case with roughpea. Legume growth was no better when fertilized with potash alone than when no fertilizer was applied.

The average yields of the three rates of phosphorus applied alone and in combination with nitrogen and potash are summarized in table 6. This further emphasizes that increases in legume growth on this soil are due mainly to the application of phosphorus.

The growth of legumes favorably affected the response of Johnsongrass to phosphorus as shown in table 7. The yields with phosphorus were reduced the first year. With roughpea the yield of Johnsongrass was 21.2 percent better than from plots with phosphorus but without roughpea. This difference amounted to 3,502 pounds of green weight per acre. The second year gave a 25.8 percent increase in yield due to the second application of phosphorus where no legume was used, but there was nearly four times as much increase following roughpea. This was a 65 percent, or 12,632 pounds, increase in green weight per acre. The application of 32 pounds of N to the phosphate treatment had its usual additive effect. The nitrogen with the phosphorus eliminated the first-year decrease with or without roughpea. The increase the second year without interplanting was approximately the same as the first year. The increase the second year with interplanted roughpeas amounted to 14,320 pounds of green weight per acre. The nitrogen from the legume added to the 32 pounds of N applied shows that Johnsongrass will respond to much higher rates of nitrogen. Even at this low rate of N, the associated roughpea raised the yield of Johnsongrass 12,605 pounds per acre over the same fertilized Johnsongrass which was grown without roughpea. The trend of yield with roughpea was higher but typical for the other legumes used.

The stimulated legume growth would leave a larger amount of nitrogenous material in the soil which would increase the growth of Johnsongrass due to the released nitrogen. The phosphated legumes also contain more phosphorus and should protect a certain amount of phosphorus from becoming unavailable in this high lime soil. Both of these factors would accumulate for a period when an equilibrium between accumulation and decomposition would be reached.

Three green weight yields of the legumes (Table 6) show an increased annual production of approximately 1 to 1½ tons of legume hay, or its equivalent in high quality pasturage. It should be emphasized that this additional yield, produced during the winter and early spring, could be utilized most efficiently. In this test this growth was removed and the increased Johnsongrass growth came from the roots of the legumes.

The chemical composition of the harvested legume top-growth produced under the various treatments is given in Table 8. These results were obtained by duplicate analyses of composited samples as indicated in this table.

The calcium content of the legumes was not altered to any great extent by the addition of the mineral fertilizers. The application of potassium alone appeared to increase the calcium content, whereas the addition of nitrogen tended to lower it.

The application of phosphate increased the phosphorus content of the legumes except in the case of black medic. The phosphorus content of Persian clover was doubled by the addition of phosphate in combination with nitrogen or potash or with both, and there was a 92 percent increase due to phosphate alone. The phosphorus content of white clover was increased 68 percent and a 57 percent increase in the phosphorus content of roughpeas was noted. The phosphorus content of all legumes was increased 30 percent by the addition of phosphate alone or in combination with nitrogen or potash or both.

The crude protein of the legumes was increased by nitrogen and phosphate, alone and in combination. This increase amounted to 12 percent when the average

Table 7. Johnsongrass yield following rough pea and no legume.

		No legume		Roughpea		Increase over no roughpea	
Fertilizer[1]	Year	Pounds per acre	Increase	Pounds per acre	Increase	Pounds	Percent
				Pounds of green weight per acre			
None	1st	17254		21181		3927	22.8
	2nd	15455		23550		8095	52.4
N	1st	25700	8446	26980	5799	1280	5.0
	2nd	19575	4120	29267	5717	9692	49.5
P	1st	16553	—701	20555	—626	3502	21.2
	2nd	19439	3984	32071	8521	12632	65.0
PN	1st	26871	9617	29703	8522	2832	10.5
	2nd	25265	9810	37870	14320	18605	49.9

[1] Footnote 1, Table 3.

Table 8. Chemical composition of interplanted legumes. Average of two years analyses. Dry weight basis.

	Black Medic			Roughpea			Persian Clover		
Fertilizer[1]	Calcium	Phosphorus	Crude protein	Calcium	Phosphorus	Crude Protein	Calcium	Phosphorus	Crude protein
O	1.6	.25	14.7	2.4	.21	22.4	2.5	.14	13.1
N	1.8	.26	17.1	1.8	.33	23.2	2.2	.24	15.2
P	2.6	.22	16.8	1.9	.33	22.6	2.4	.25	14.8
K	3.0	.12	14.7	2.0	.22	21.0	2.5	.13	12.7
NP	2.2	.22	16.4	1.9	.30	22.9	2.4	.30	15.0
PK	2.5	.22	14.2	1.9	.27	21.8	2.6	.27	13.9
PKN	2.5	.23	16.4	1.9	.30	22.8	2.6	.31	14.9
	White clover			Low hop clover			Average legumes		
O	2.2	.19	15.2	2.3	.27	14.3	2.2	.21	15.9
N	2.2	.32	17.7	2.0	.29	16.3	2.0	.29	17.9
P	2.2	.25	18.6	2.3	.30	16.3	2.3	.27	17.8
K	2.5	.26	17.2	2.4	.17	12.8	2.5	.18	15.7
NP	2.4	.24	17.4	2.2	.32	18.5	2.2	.28	18.0
PK	2.2	.28	16.9	2.3	.22	15.9	2.3	.25	16.6
PKN	2.1	.29	18.9	1.9	.30	18.6	2.2	.29	18.3

[1] Footnote 1, Table 3.

Table 9. Phosphorus content of Johnsongrass following interplanted legumes.

Fertilizer[1]	No Legume	Black medic	Roughpea	Persian clover	White clover	Low hop clover	Average all legumes
			Percent on dry weight basis				
			FIRST HARVEST				
O	.23	.25	.24	.15	.21	.21	.21
N	.28	.32	.43	.22	.36	.26	.32
P	.26	.29	.32	.25	.31	.24	.28
K	.19	.21	.18	.16	.21	.19	.19
NP	.29	.27	.39	.26	.38	.29	.34
PK	.31	.30	.38	.21	.38	.28	.32
PKN	.28	.30	.36	.24	.36	.25	.30
			SECOND HARVEST				
O	.15	.13	.14	.13	.15	.15	.14
N	.15	.16	.17	.16	.16	.17	.16
P	.21	.22	.20	.21	.21	.21	.21
K	.19	.17	.18	.17	.19	.19	.18
NP	.18	.20	.20	.21	.19	.19	.20
PK	.18	.18	.17	.19	.18	.20	.18
PKN	.19	.23	.21	.22	.19	.22	.21

[1] Footnote 1, Table 3.

of all the legumes was considered. Low Hop clover increased most. Phosphate and nitrogen alone gave a 14 percent increase, and 29 percent when applied together. The average of the applications of phosphorus to white clover gave 22 percent increase. Overall, application of phosphorus, alone or in combination, increased the crude protein of all the legumes. Potassium resulted in a 4.4 percent increase when the average of all legumes is considered. This was due to the 13 percent increase in white clover; while there was some little reduction with other legumes. This reduction was somewhat offset by the addition of phosphorus to the potash.

The phosphorus content of Johnsongrass following interplanted legumes is given in table 9. It will be seen that the phosphorus content of the Johnsongrass was increased by application of fertilizers both with and without interplanted legumes. The increase was greater following the legumes. The combination of phosphorus and potash gave almost the same increase in phosphorus content as the combination of phosphorus and nitrogen. The phosphorus content of the first harvest was adequate for animal nutrition but was slightly deficient in the second harvest.

The crude protein content of Johnsongrass following interplanted legumes is given in table 10. All fertilizers increased the crude protein content with or without an interplanted legume. There was a greater increase when an interplanted legume was used. Most of the increase resulted from applications of nitrogen, alone or in combination, and a further increase resulted from a combination of a legume and nitrogen. This emphasizes the need for greater applications of nitrogen to Johnsongrass, from both a yield and composition standpoint.

Recommendations

These tests show the value of an interplanted legume in the production of Johnsongrass. Roughpea, white clover, and Persian clover would be recommended on this type of soil. The interplanted legume produces 1 to 1½ tons of legume hay or its equivalent in pasturage which would be in addition to the production of Johnsongrass.

The tests indicate an annual fall application of at least 60 pounds of P_2O_5 per acre. At least 32 pounds of nitrogen should be applied after each cutting of Johnsongrass. The need for higher rates of nitrogen and phosphorus for Johnsongrass is also shown.

Table 10. Crude protein content of Johnsongrass following interplanted legumes.

Fertilizer[1]	No Legume	Black medic	Roughpea	Persian clover	White clover	Low hop clover	Average all legumes
			Percent on dry weight basis				
			FIRST HARVEST				
O	8.4	9.0	12.0	8.1	11.9	11.5	10.7
N	10.5	12.4	13.2	10.0	12.8	13.3	12.3
P	10.0	11.1	12.9	10.0	12.0	10.2	11.2
K	9.3	11.2	11.6	9.6	12.0	11.0	11.2
NP	9.9	12.3	12.5	11.8	12.7	11.6	12.2
PK	9.0	12.2	13.0	11.4	11.8	11.6	12.0
PKN	10.7	12.6	13.5	11.9	12.2	11.9	12.4
			SECOND HARVEST				
O	3.9	4.5	3.9	3.8	3.9	4.1	4.0
N	4.5	4.7	4.7	5.0	4.8	4.5	4.7
P	4.4	4.4	4.1	4.7	5.4	4.8	4.7
K	3.5	4.6	3.9	3.6	4.1	4.6	4.2
NP	3.9	4.9	3.9	4.4	4.9	4.5	4.5
PK	4.2	4.4	3.7	4.1	5.2	4.4	4.4
PKN	4.0	4.1	4.2	4.3	4.4	4.7	4.3

[1] Footnote 1, Table 3.

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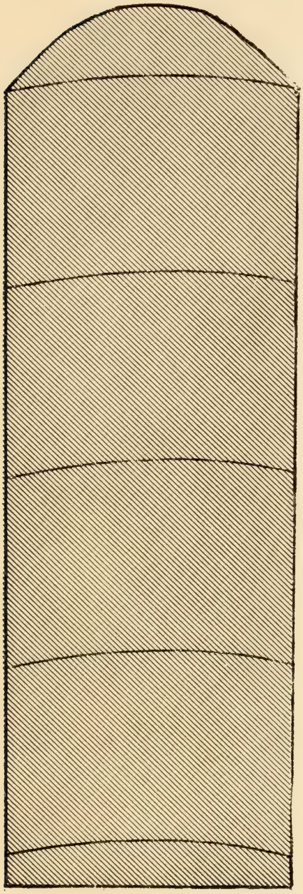

Comparison of Silage and Haylage For Dairy Cattle

By C. B. BROWNING AND
J. W. LUSK

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SUMMARY

The work reported here indicates that wilted sudangrass (30-35% DM) silage can be successfully stored in conventional concrete tower silos with low dry matter losses from spoilage and fermentation when proper technique is used.

This study further shows that wilted sudangrass silage and direct-cut grain sorghum silage from conventional storage compare favorably in chemical composition, digestibility, and feeding value with the same forages stored under gas tight conditions.

There is little doubt that greater attention to ensiling detail is required if high quality forages with low storage losses are to be attained with conventional storage than with gas-tight storage. However, factors such as selection of crop, stage of maturity and proper harvesting procedures would appear to be more important to the quality of silage than the type of storage structure used.

COMPARISON OF SILAGE AND HAYLAGE FOR DAIRY CATTLE

By C. B. BROWNING AND J. W. LUSK

During recent years there has been an increased interest in haylage for dairy cattle. Haylage may be defined as a wilted "hay crop silage" that contains 45% or more dry matter stored in a "gas-tight" silo. However in common usage the term haylage has come to refer to any wilted hay crop silage regardless of the dry matter content or the type of silo used for storage. Although there is no definite percentage of dry matter that a wilted forage must contain to be termed "haylage" probably a more correct designation for ensiled forages containing between 30 and 40% dry matter would be "low-moisture silage."

The practice of wilting hay crop silages is not new and has been a standard recommendation for many years. It is the feeling of most authorities that a hay crop for silage must be wilted or have 150 to 200 lb. of crushed ear corn or some similar material added per ton of green forage at ensiling to insure good results.

The renewed interest in wilted silage and the new interest in gastight storage prompted the Dairy Science Department to initiate studies designed to answer basic questions concerning these practices for Mississippi livestock producers.

The objectives of the studies conducted during the past two years and reported here were (1) to determine if there were differences in the quality of forages stored in concrete tower silos and the same forages stored in gas-tight structures (2) to measure relative storage losses between the two types of structures.

Direct comparisons have been made between conventional storage (concrete tower silos) and gas-tight storage (Harvestores[1]) with four forages. During 1962 RS610 grain sorghum silage and Greenleaf sudangrass silage were ensiled under both systems. During 1963 Sudax (SX11) and Greenleaf sudangrass forages were ensiled under both systems. During both years the sudangrass and the Sudax were cut at 36 to 40 inches in height, crimped, wilted, finely chopped and ensiled. The RS610 was direct-cut in a milk to dough stage of maturity.

The chemical composition of these eight forages is given in Table 1, which shows no apparent differences among the chemical components of the forages that could be related to the type of structure used for storage. Attention is called to the relatively high ash content of the sudangrass forages which resulted from soil picked up on the forages during harvesting following wilting. The sudangrass harvested during 1963 was less mature than that harvested during 1962. It was higher in crude protein, slightly lower in crude fiber, and contained less foreign material as evidenced by the lower ash content.

Silage Quality

A three treatment double reversal type feeding trial with 18 lactating cows was used to compare the relative feeding value of three forages harvested during 1962. The forages compared were RS610 grain sorghum silage from conventional storage and Greenleaf sudangrass from conventional as well as gas-tight storage. Results of this feeding trial are given in Table 2. The cows fed RS610 silage from conventional storage consumed more silage and produced significantly more 4% milk than the cows fed either of the sudangrass forages. There was no difference in the consumption of sudangrass from conventional storage and that stored in the Harvestore, nor was there a difference in the daily milk production

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[1] Two 17 x 40' Harvestores were donated to the Dairy Science Department by the Harvestore Division, A. O. Smith, Inc., Arlington Heights, Ill.

Table 1. Comparison of the average chemical composition at feeding of four forages stored in conventional and gas-tight silos.

Year and forage	Structure	Dry Matter	Chemical Composition CP Crude Protein	CF Crude Fiber	EE Crude Fat	NFE Nitrogen Free Extract	ASH
1962	Concrete	26.6	9.4	28.7	2.7	52.5	6.6
RS610	Gas-tight	27.5	9.4	27.9	3.0	53.1	6.5
1962	Concrete	38.7	11.1	30.2	2.9	40.8	15.0
Sudan	Gas-tight	52.0	10.5	29.6	3.1	41.2	15.6
1963 SX11	Concrete	30.7	12.5	32.4	3.5	41.8	9.8
(Sudax)	Gas-tight	40.4	12.6	32.3	3.3	43.2	8.9
1963	Concrete	30.5	13.6	27.7	3.5	43.0	12.3
Sudan	Gas-tight	56.4	12.1	30.6	2.8	43.1	11.4

Table 2. Summary of 1962-63, 1963-64 results from two trials (36 cows) comparing RS610 grain sorghum silage stored in a concrete silo and Greenleaf sudangrass stored in a concrete silo and a Harvestore.

Measurement	Year	RS610 Concrete silo	Sudangrass Concrete Silo	Harvestore
Daily 4% prod./cow (lb.)	1962	38.0[1]	36.4	35.5
	1963	40.7	42.2	38.2
Fat test (%)	1962	4.8	4.3	4.2
	1963	4.2	4.2	4.2
Silage or haylage Intake DM/1000 lb. Body weight (lb.)	1962	17.8	15.6	16.0
	1963	17.1	15.0	13.9
Total forage DM Intake[2] (lb.)	1962	22.0	19.8	20.2
	1963	21.5	19.4	18.3
Silage or haylage DM (%)	1962	26.6	32.3	45.8
	1963	28.1	30.5	55.3

[1] Any two means not underscored by the same line are significantly different (.05).

[2] Includes 4.2 lb. of alfalfa hay fed daily per cow in 1962 and 4.4 in 1963.

for the cows receiving these forages.

A second feeding trial of identical design using the same forages produced the following year was conducted during the winter of 1963-64. As mentioned previously in the discussion on chemical composition, the sudangrass forage harvested in 1963 appeared to be superior to that harvested in 1962. Although the cows consumed significantly more dry matter when fed RS610 than they did when fed the sudangrass from conventional storage there was not a significant difference in average daily production. The cows consumed less sudangrass forage from the Harvestore and produced less milk than the cows fed either of the other two forages.

In an effort to further characterize the feeding value of forages stored under conventional and air-tight systems digestion trials were conducted. Table 3 gives the results of a digestion trial comparing RS610 and sudangrass from the two type of storage structures. In general there was no significant difference in the digestibility of the various fractions studied as a result of the type of storage used. The only exception was the low digestion coefficient for the crude protein fraction of the sudangrass from the gas-tight structure. This forage had a crude protein digestion coefficient of 35.3% as compared to the digestion coefficient of 50.0% for the same forage stored in a concrete silo. Of particular interest is the fact that the high dry matter sudangrass forage from the gas-tight structure (46.0% DM) was not consumed in greater amounts nor was it more digestible than the sudangrass forage from the conventional structure that contained forage with only 34.9% dry matter.

Research from other stations seems to indicate that alfalfa silage is consumed in greater quantities as the dry matter of the silage is increased from 30% to 50%. Based on the results of the two milk production studies previously discussed this does not appear to be true with sudangrass. The two-year average forage dry matter content was 31.4% for the sudangrass stored in the concrete silo and 50.6% for the sudangrass stored in the Harvestore. The two-year average for dry matter intake was 15.3 lb. per 1000 lb. body weight for the conventionally stored sudangrass and 15.0 for the sudangrass from the Harvestores.

Table 4 gives results of a digestion trial comparing the forages fed in the lactation study conducted during 1963-64 and the digestion coefficients of Sudax forage from a gas-tight structure. As in-

Table 3. Summary of results from a digestion trial comparing sudangrass and RS610 grain sorghum stored in gas-tight and concrete silos.

	RS610		Sudangrass	
Measurement	Concrete	Gas-tight	Concrete	Gas-tight
Dry matter as fed (%)	26.7	28.5	34.9	46.0
Voluntary intake DM/1000 lb. Body weight (lb.)	14.2[1]	14.1	14.4	12.4
Digestion Coefficients (%)				
DM	61.0	60.3	50.4	52.0
Cellulose	59.1	61.8	70.8	68.9
Crude protein	57.4	52.6	50.0	35.3
Energy	61.8	62.6	60.2	57.1

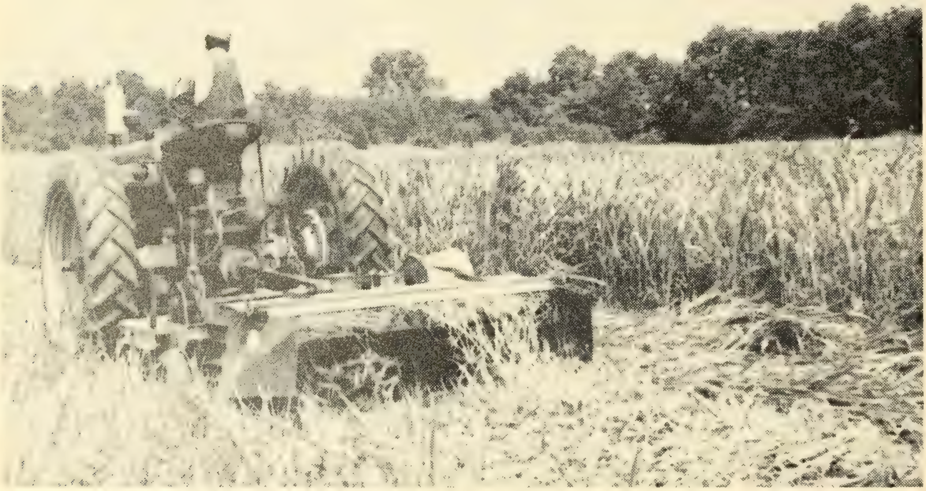
[1] Any two means not underscored by the same line are significantly different (.05).

Table 4. Summary of results from a digestion trial comparing forages stored in gas-tight and concrete silos.

	RS610	Sudangrass		SX11
Measurement	Concrete	Concrete	Gas-tight	Gas-tight
DM as fed. (%)	28.2	32.0	53.9	45.6
Voluntary intake DM/1000 lb. Body weight (lb.)	16.8[1]	17.9	17.1	15.3
Digestion Coefficients (%)				
DM	58.4	60.4	63.0	60.6
Cellulose	60.3	79.2	78.0	74.7
Crude protein	57.2	57.0	46.8	42.8
Energy	58.9	68.1	64.5	60.9

[1] Any two means not underscored by the same line are significantly different (0.5).

RS610 grain sorghum (above) and sudangrass (below) were used in this forage study.



dicated in the previous study, the crude protein digestion coefficient for the sudangrass forage from the gas-tight structure was significantly lower than the digestion coefficient for crude protein of the sudangrass forage from the conventional structure. The reason for the lowered digestibility of crude protein in some of the forages is not known. However at present it is thought to be more directly associated with the dry matter content of the forage at ensiling than with the type of storage used.

Storage Losses

Silage dry matter losses as a result of seepage, spoilage, and fermentation were determined for the several silages stored under conventional and gas-tight systems. Standard recommended ensiling practices were used in all cases. The silages stored in the concrete silos were well distributed during filling, were packed during the filling of the upper one-half of the silos and were capped with a plastic cover. The forages stored in the Harvestores were well distributed and the structures were sealed to maintain gas-tight conditions.

A summary of the storage losses encountered with the two systems is given in Table 5. The average dry matter loss for three hay crop silages stored in concrete silos was 6.9% of the total dry matter stored. This compares with a 5.3% dry matter loss for the same forages stored in gas-tight structures. Both of these figures are extremely low and represent what can be accomplished when the proper harvesting and ensiling techniques are practiced.

The RS610 grain sorghum silage (26.4% DM) ensiled in the Harvestore had a high seepage loss that amounted to 1.2% of the total dry matter stored. The seepage loss from the same RS610 stored in the conventional silo was not measured directly but was included in the fermentation loss. The total dry matter loss was 7.1% for the RS610 from the conventional silo and 9.8% for that from the Harvestore.

The Harvestore structures have been filled to capacity on four occasions with forages of different dry matter percentages. This gave the opportunity to compare their capacity as related to the dry matter content of forage at time of ensiling. When sudangrass containing approximately 52% dry matter was ensiled the capacity of a 17' x 40' Harvestore was 40.2 tons of dry matter, comparable figures for Sudax at 46% dry matter was 37.2 tons; RS610 at 26% dry matter 43.5 tons; and RS610 at 31% dry matter 45.5 tons.

Table 5. Comparative dry matter losses of four forages stored in concrete silos and Harvestores.

Year forage structure	Dry matter as ensiled	Dry matter losses			
		Top spoilage	Seepage	Fermentation[1]	Total
		—(%)—			
1962-63					
Sudangrass					
Concrete	38.1	0.50[2]	0	4.9	5.4
Harvestore	52.4	Nil	0	3.1	3.1
Grain Sorghum					
Concrete	25.8	0.43	[2]	6.7	7.1
Harvestore	26.4	0	1.2	8.6	9.8
1963-64					
Sudangrass					
Concrete	32.9	0.30	0	3.6	3.9
Harvestore	56.2	Nil	0	2.2	2.2
SX11 (Sudax)					
Concrete	36.5	0.50	0	11.1	11.06
Harvestore	46.6	Nil	0	10.6	10.6

[1] Fermentation loss determined by weigh-in and weigh-out measurements for the Harvestores and the "buried-bag" technique for the concrete silos.

[2] Seepage loss is considered in fermentation loss by the "buried-bag" technique.

BULLETIN 700 JANUARY 1965

Mississippi Cotton Variety Tests, 1964

Mississippi State University

AGRICULTURAL EXPERIMENT STATION

HENRY H. LEVECK, Director

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Mississippi Cotton Variety Tests For 1964

IN THE DELTA

By JAMES B. DICK and ROBERT H. LOE[1]

Testing of cotton varieties is a necessary function of State Experiment Stations in areas of cotton production to provide information on the relative value of varieties being offered for sale. As new varieties are developed the varietal situation requires continuous appraisal. Of 12 varieties included in the Delta variety tests in 1954, ten years ago, only four were in the 1964 tests. Seed of the other 8 varieties is no longer sold.

Cotton variety trials were conducted by the Delta Branch Experiment Station at four locations during the years 1962, 1963, and 1964. One location was the Delta Experiment Station at Stoneville. Cooperative trials were conductd on the Woolfolk Farms 6 miles north of Tunica, with the cooperation of Messrs. Scott Arnold Jr., Dunlap Rose, Jr., and County Agent Hayes Farish; on the Heaton Plantation at Clarksdale with the cooperation of Mr. W. S. Heaton, Jr., and County Agent R. P. Lewis; and on the Schaefer Plantation north of Yazoo City with the cooperation of Mr. Emile Schaefer.

The 1964 season was very favorable for cotton production over the Delta as a whole. An unfortunate local drought at Clarksdale destroyed the validity of the 1964 test and yields were not recorded. Excessive rainfall in July and August damaged the Yazoo City test.

Current strains of 16 commercial varieties were grown in the 1964 variety trials. Thirteen of these varieties were also grown in trials in 1962 and 1963. The Stoneville and Tunica trials are a part of a beltwide variety testing program.

Results are reported for the 1964 tests and for 2-year and 3-year averages for each location. In each case yield data were taken from solid plantings of replicated and randomized 2-row plots in each test. Other data were determined from samples taken at first harvests. Money value per acre was computed by adding the Commodity Credit Corporation loan value for the staple length of each variety for Strict Low Middling grade and the seed value at $52.00 a ton. No allowance was made for ginning. Varieties are listed in each table in order of dollar value per acre. Classing was done by the Staple Cotton Cooperative Association in Greenwood, Mississippi. Fiber properties data were determined by the fiber laboratory of Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, at Knoxville, Tennessee.

More attention is being given to fiber fineness than ever before. In 1964 Delta cotton had higher micronaire values than normal, with three of the 16 varieties in the variety tests averaging above 5.00. In the 3-year averages the micronaire indexes for all varieties fell between 4.03 and 4.86.

Many textile mills are now greatly interested in fiber strength as well as staple length. Most Delta varieties possess fairly good fiber strength, with T_1 values averaging 1.81 to 1.96. (Approximately 72,400 to 78,400 pounds per square inch.) All of these varieties have staple lengths of 1 1/16 to 1 3/32 inches.

Results of the 1964 trials and averages of previous years are shown in the accompaning tables.

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[1] Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and former Assistant Agronomist, Delta Branch Experiment Station, Mississippi Agricultural Experiment Station. This report is based upon results from cooperative research conducted by the Mississippi Agricultural Experiment Station and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

Table 1a.—Yield, earliness, lint percent, boll size, fiber properties, and gross money value for the 1964 cotton variety test at Stoneville, Mississippi.

Stoneville	Yield pounds lint per acre		Percent at first pick	Per-cent lint	Number bolls per pound		Fiber properties					Gross value per acre (SLM)
							Staple length		Stren-gth (T_1-	Elon-gation (E_1)	Micro-nair	
Variety	Total	First pick			Seed cotton	Lint	Classer	UHM				
	lbs.	lbs.	pct.	pct.	no.	no.	inch	inch	index	index	index	dollars
Stoneville 7A	1369	1006	74	38.6	76	198	1 1/16+	1.16	2.01	7.3	5.19	$ 467
McNair 1032	1295	874	68	36.3	71	196	1 1/16—	1.05	2.09	9.2	5.01	447
Stoneville 213	1312	990	75	39.4	77	195	1 1/16	1.11	1.98	8.3	5.17	446
Deltapine 15	1293	888	69	39.3	75	190	1 1/16	1.11	2.18	9.0	4.57	440
Deltapine						180	1 3/32	1.11	2.03	10.5	5.02	435
Smooth Leaf	1263	910	72	39.7	72	188	1 1/16	1.12	1.91	9.2	4.67	432
Auburn 56	1236	878	71	34.4	65	161	1 1/16	1.12	2.05	7.4	5.21	426
Carolina Queen	1244	790	64	37.9	61	168	1 1/16	1.11	2.02	6.5	4.97	401
Dixie King II	1165	838	72	37.1	62	186	1 1/16	1.08	2.10	8.9	5.04	393
Deltapine 45	1149	895	78	38.4	72	190	1 1/16	1.17	1.99	6.6	4.63	379
Coker 100A	1086	750	69	34.8	66	179	1 3/32	1.18	1.99	7.7	4.42	378
Delfos 9169	1062	804	76	34.0	61	196	1 1/16	1.12	2.18	7.7	4.91	374
Stardel	1097	888	81	38.6	74	177	1 1/16	1.09	1.97	7.3	4.98	367
DeKalb 220	1069	797	75	37.4	66	153	1 1/16	1.13	1.98	6.8	4.19	357
Empire WR 61	1029	750	73	35.4	54	197	1 1/16	1.09	1.99	8.2	4.46	353
Auburn M	1018	864	85	35.4	70	175	1 1/16	1.09	1.81	8.8	4.39	343
Rex Smooth Leaf	994	812	82	36.5	64				2.02		4.80	
Averages	1168			31.1								
LSD at 5% level	215											
CV	13.0%											

Planted May 1; harvested September 22 and October 22. Soil: Deer Creek sandy loam.

Table 1b.—Yield and other data for cotton variety tests at Stoneville; 3-year averages, 1962-1964.

Stoneville

Variety	Yield lint pounds per acre	Lint percent	Fiber properties				Gross value per acre (SLM)
			Staple length		Strength		
			Classer	UHM	(T_1)	Micronaire	
	lbs.	pct.	1/32 inch	inch	index	index	dollars
Stoneville 213	1259	38.6	34.7	1.14	1.92	5.13	454
Stoneville 7A	1229	37.8	35.0	1.17	1.93	5.18	443
Auburn 56	1142	34.3	34.3	1.12	1.96	4.66	420
Deltapine Smooth Leaf	1150	38.4	34.7	1.14	2.04	4.96	415
DeKalb 220	1112	36.6	34.3	1.12	1.88	4.81	406
Deltapine 15	1106	38.9	34.7	1.14	2.06	4.75	396
Dixie King	1084	36.0	34.7	1.13	1.97	4.85	395
Stardel	1079	37.2	34.7	1.14	2.08	4.81	392
Delfos 9169	1040	33.1	35.3	1.20	1.89	4.29	390
Coker 100A	1044	35.1	34.7	1.17	1.92	4.71	383
Auburn M	1028	35.2	34.0	1.11	1.96	4.34	376
Rex Smoothleaf	1022	35.9	34.3	1.12	1.84	4.31	374
Empire WR 61	985	34.8	34.3	1.13	1.89	4.19	361

Table 3.—Yield and other data for cotton variety tests at Clarksdale; 2-year averages, 1961-1963.

Clarksdale

Variety	Yield lint pounds per acre	Lint percent	Fiber properties				Gross value per acre (SLM)
			Staple length		Strength		
			Classer	UHM	(T_1)	Micronaire	
	lbs.	pct.	1/32 inch	inch	index	index	dollars
Stoneville 213	843	37.1	35.0	1.12	1.88	4.58	315
Stoneville 7A	774	37.2	34.5	1.12	1.82	4.40	288
DeKalb 220	728	34.4	34.5	1.13	1.93	3.87	283
Deltapine Smooth Leaf	750	36.0	35.0	1.13	1.98	4.10	281
Auburn 56	724	33.2	35.0	1.10	1.90	3.85	277
Dixie King	690	33.9	34.5	1.11	1.90	4.08	724
Auburn M	709	33.0	34.5	1.08	1.95	3.60	271
Stoneville 3202	720	35.6	34.5	1.04	1.70	4.02	270
Fox 4	706	34.2	34.5	1.12	1.97	4.27	267
Coker 1000	698	34.1	35.0	1.13	1.92	4.06	266
DeKalb 108	694	33.1	35.0	1.13	1.87	3.90	266
Deltapine 15	707	36.3	34.5	1.11	2.00	4.12	265
Delta Queen	682	33.3	35.0	1.14	1.90	3.87	261
Stardel	683	35.9	35.0	1.11	1.90	4.18	257
Rex Smoothleaf	673	33.6	34.5	1.11	1.80	3.92	255
Delfos 9169	615	31.8	36.0	1.16	1.88	3.70	239
Empire WR 61	584	33.4	34.5	1.09	1.87	4.00	222

Table 2a.—Yield, earliness, lint percent, fiber properties, and gross money value for the 1964 cotton variety test at Tunica, Mississippi.

Tunica

Variety	Yield pounds lint per acre		% at first pick	Per-cent lint	Fiber properties					Gross value per acre (SLM)
	Total	First pick			Staple length		Strength (T_1)	Elongation (E_1)	Micronaire	
					Classer	UHM				
	lbs.	lbs.	pct.	pct.	inch	inch	index	index	index	dollars
Stoneville 213	1413	934	66	40.0	1 1/16	1.07	1.69	7.7	5.24	479
Stoneville 7A	1367	890	65	40.4	1 1/16	1.08	1.82	7.7	5.06	462
Auburn 56	1323	865	65	36.6	1 1/16	1.09	1.82	7.8	4.55	456
DeKalb 220	1326	773	58	37.8	1 1/16	1.10	2.03	7.3	4.83	454
Carolina Qn.	1320	776	59	39.4	1 1/16	1.09	1.95	7.0	5.12	449
Deltapine 45	1312	884	67	39.7	1 1/16	1.06	1.94	8.0	4.97	446
Coker 100A	1301	810	62	38.5	1 1/16	1.09	1.79	7.2	4.84	444
Dixie King II	1285	700	54	38.4	1 1/16	1.06	1.86	6.8	4.85	439
McNair 1032	1282	796	62	38.1	1 1/16	1.03	1.98	7.1	4.88	439
Stardel	1271	694	55	39.7	1 1/16	1.08	2.03	6.2	5.02	431
Deltapine 15	1271	597	47	40.3	1 1/16	1.09	1.94	9.0	4.43	430
Deltapine SL	1252	680	54	39.7	1 1/16	1.10	1.87	8.5	4.47	425
Delfos 9169	1203	734	61	35.5	1 3/32	1.14	1.79	8.0	4.41	424
Auburn M	1168	718	62	36.1	1 1/16	1.07	1.91	7.9	4.38	404
Empire WR 61	1062	778	73	35.9	1 1/16	1.08	1.70	6.6	4.19	368
Rex Smlf.	1051	746	71	35.7	1 1/16	1.09	1.86	7.7	4.39	364
Averages	1263			32.2			1.87			
LSD at 5% level	147									
CV		8.2%								

Planted April 30; harvested September 15 and October 27.
Soil: Sandy loam.

Table 2b.—Yield and other data for cotton variety tests at Tunica; 3-year averages, 1962-1964.

Tunica

Variety	Yield pounds lint per acre	Lint percent	Fiber properties				Gross value per acre (SLM)
			Staple length		Strength (T_1)	Micronaire	
			Classer	UHM			
	lbs.	pct.	1/32 inch	inch	index	index	dollars
Stoneville 213	1316	39.2	34.7	1.11	1.79	4.94	471
DeKalb 220	1166	36.8	34.3	1.13	1.86	4.27	422
Delfos 9169	1130	34.4	35.3	1.17	1.80	4.19	420
Coker 100A	1151	37.2	34.7	1.15	1.80	4.66	417
Deltapine Smooth Leaf	1159	38.5	34.3	1.12	1.85	4.33	417
Stoneville 7A	1164	39.2	34.3	1.13	1.82	4.75	415
Auburn 56	1135	35.5	34.3	1.10	1.84	4.24	414
Dixie King	1101	36.8	34.7	1.11	1.81	4.37	398
Stardel	1108	38.2	34.3	1.12	1.94	4.68	398
Deltapine 15	1073	39.1	34.7	1.13	1.92	4.27	384
Auburn M	1040	35.5	34.3	1.11	1.88	4.05	379
Rex Smoothleaf	971	35.5	34.3	1.12	1.80	4.16	354
Empire WR 61	922	34.8	34.3	1.11	1.77	4.04	337

Table 4a.—Yield, lint percent, fiber properties, and gross money value for the 1964 cotton variety test at Yazoo City, Mississippi.

Yazoo City

Variety	Yield lint pounds per acre	Percent lint	Fiber properties: Staple length Classer	Staple length UHM	Strength (T_1)	Elongation (E_1)	Micronaire	Gross value per acre (SLM)
	lbs.	pct.	inch	inch	index		index	dollars
Stoneville 7A	1000	40.0	1 1/16+	1.09	1.92	7.3	4.85	341
McNair 1032	986	38.0	1 1/16	1.05	2.03	7.2	4.82	338
Delfos 9169	947	35.3	1 3/32	1.16	1.86	8.5	4.33	334
Auburn 56	910	36.0	1 1/16	1.06	1.77	8.3	4.39	315
Deltapine 15	931	41.0	1 1/16	1.09	1.82	9.2	4.51	314
Dixie King II	905	39.2	1 1/16	1.07	1.88	7.0	4.78	308
Rex Smlf.	894	38.0	1 1/16	1.07	1.81	7.9	4.25	306
Deltapine Smlf.	892	40.3	1 1/16+	1.08	1.97	9.1	4.88	304
Stoneville 213	896	40.0	1 1/16	1.10	1.73	7.7	5.06	404
DeKalb 220	870	37.8	1 1/16+	1.11	1.78	8.2	4.57	300
Coker 100A	840	37.4	1 3/32	1.12	1.86	7.6	4.68	293
Caroline Qn.	852	39.8	1 1/16	1.12	1.78	7.4	5.08	289
Deltapine 45	840	39.6	1 1/16	1.10	1.91	8.2	4.84	285
Stardel	801	39.6	1 1/16	1.08	1.92	7.1	4.71	272
Empire WR61	786	3.70	1 1/16	1.07	1.81	7.3	4.04	271
Auburn M	720	36.0	1 1/16	1.07	1.82	8.0	4.04	249
Averages	879	38.4			1.85		4.61	
LSD at 5 % level	145							
CV	11.5%							

Soil: Sandy loam.
Planted April 21; harvested September 10 and October 20.

Table 4b.—Yield and other data for cotton variety tests at Yazoo City; 3-year averages, 1962-1964.

Yazoo City

Variety	Yield lint pounds per acre	Lint percent	Fiber properties: Staple length Classer	Staple length UHM	Strength (T_1)	Micronaire	Gross value per acre (SLM)
	lbs.	pct.	1/32 inch	inch	index	index	dollars
Stoneville 7A	1686	39.8	34.7	1.11	1.87	4.92	390
Stoneville 213	1074	39.3	34.7	1.10	1.83	4.78	388
Auburn 56	1009	35.8	34.7	1.08	1.82	4.34	371
Deltapine Smooth Leaf	1007	39.5	35.0	1.10	1.95	4.73	365
DeKalb 220	975	37.2	34.7	1.11	1.84	4.43	355
Rex Smoothleaf	947	37.3	34.3	1.09	1.78	4.20	343
Deltapine 15	956	39.7	34.7	1.10	1.93	4.47	343
Dixie King	931	37.3	34.7	1.07	1.84	4.62	339
Delfos 9169	985	34.9	35.3	1.16	1.87	4.13	336
Coker 100A	903	36.6	35.0	1.12	1.89	4.53	332
Stardel	889	38.9	34.7	1.09	1.97	4.63	320
Empire WR 61	874	37.0	34.3	1.08	1.84	4.20	319

Table 5.—Average yield per acre, lint percent, staple length, fiber strength, and micronaire for 16 varieties grown at three Delta locations in 1964.

Averages

Variety	Yield pounds lint per acre	Lint percent	Fiber properties: Staple length Classer	Fiber properties: Staple length UHM	Fiber properties: Strength (T_1)	Fiber properties: Micronaire	Gross value per acre (SLM)
	lbs.	pct.	1/32 inch	inch	index	index	dollars
Stoneville 7A	1245	39.7	34.3	1.11	1.92	5.03	423
Stoneville 213	1207	39.8	34.0	1.09	1.80	5.16	410
McNair 1032	1190	37.5	34.0—	1.04	2.03	4.90	408
Auburn 56	1156	35.7	34.0	1.09	1.83	4.54	401
Deltapine 15	1165	40.2	34.0	1.10	1.98	4.50	395
Deltapine Smlf.	1136	39.9	34.5	1.10	1.96	4.80	388
Carolina Queen	1140	39.0	34.0	1.11	1.93	5.14	388
Dixie King II	1118	38.2	34.0	1.08	1.92	4.87	383
Delfos 9169	1070	34.9	35.0	1.16	1.88	4.40	379
Deltapine 45	1100	39.2	34.0	1.08	1.98	4.95	375
DeKalb 220	1088	37.7	34.2	1.10	1.93	4.80	374
Coker 100A	1076	36.9	34.3	1.13	1.88	4.72	372
Stardel	1056	39.3	34.0	1.09	2.04	4.88	359
Rex Smoothleaf	980	36.7	34.0	1.08	1.83	4.34	338
Auburn M	970	35.8	34.0	1.08	1.90	4.30	335
Empire WR 61	960	36.1	34.0	1.09	1.83	4.14	332

Table 6.—Average yield, money value, lint percent, and fiber properties for 13 cotton varietie grown in 11 yield trials in 4 Delta locations in 1962, 1963, and 1964.

Averages

Variety	Yield lbs. lint per acre	Gross value per acre (SLM)	Lint percent	Fiber properties: Staple length Classer	Fiber properties: Staple length UHM	Fiber properties: Strength (T_1)	Fiber properties: Micronair
	lbs.	dollars	pct.	1/32 inch	inch	index	index
Stoneville 213	1123	407	38.6	34.8	1.12	1.86	4.86
Stoneville 7A	1063	384	38.5	34.6	1.13	1.86	4.81
Alburn 56	1002	370	34.7	34.6	1.10	1.88	4.27
Deltapine Smlf.	1017	370	38.1	34.8	1.12	1.96	4.53
DeKalb 220	995	367	36.3	34.5	1.12	1.88	4.35
Dixie King	952	352	36.0	34.7	1.11	1.88	4.48
Coker 100A	949	349	35.8	34.9	1.14	1.88	4.49
Deltapine 15	961	347	38.5	34.7	1.12	1.98	4.40
Delfos 9169	943	346	33.6	35.5	1.17	1.86	4.08
Stardel	940	342	37.6	34.7	1.12	1.97	4.03
Auburn M	913	335	34.9	34.3	1.10	1.90	4.03
Rex Smoothleaf	903	332	35.6	34.4	1.10	1.81	4.15
Empire WR 61	841	310	35.0	34.4	1.10	1.84	4.11

COTTON TESTS IN HILL SECTION

By G. D. GREEN, R. C. ALBRITTON, R. E. COATS, S. P. CROCKETT, W. J. GILL, B. C. HURT, JR., and B. E. WAGGONER

Sixteen varieties were included in these Experiment Station tests in 1964. All seed came from the breeder or sponsor of the variety. Four varieties previously tested which were not entered by their breeders this year were Deltapine 15, Fox 4, Delta Queen and Coker 124B. Pennington HY-BEE, a so-called strain cross, was the only new entry. DeKalb 108 and 220 are called strain crosses, also.

Tests were conducted at the Central Station, State College; the Black Belt Branch Station, Brooksville; the Coastal Plain Branch Station, Newton; the Brown Loam Branch Station, Raymond; one on flatwoods and one on Pontotoc Ridge soil at the Pontotoc Station, Pontotoc; one on hill land on the station and one on bottom land on the farm of Mr. C. C. Moore about 4½ miles north of Holly

Summary Tables

Summary Table showing average yields of cotton varieties which have been in all the Hill Station tests for five or more years, in pounds of lint per acre for years indicated.

Variety	State College 60-64	Brooksville 60-64	Newton 59-61 & 63-64	Raymond 60 & 62-64	Pontotoc		Holly Springs		Verona 59 & 62-64	Average
					Flatwoods 60-64	Ridge 60-64	Hill 60-64	Bottom 61-64		
Stoneville 3202	672	861	635	790	637	788	812	1014	879	788
Auburn 56	712	785	661	778	632	807	861	1001	813	783
Dixie King	670	798	638	685	659	774	818	944	853	760
Coker 100A, WR	665	826	636	645	644	794	811	1020	780	758
Deltapine SM Lf.	676	860	629	784	578	736	739	943	807	750
Delfos 9169	635	762	541	687	557	667	797	926	760	704

Summary Table showing average yields in Hill Station cotton variety tests in 1964, in pounds of lint per acre.

Variety	State College	Brooksville	Newton	Raymond	Pontotoc		Holly Springs		Verona	Average
					Flatwoods	Ridge	Hill	Bottom		
Stoneville 213	728	928	762	942	708	831	1115	1317	773	900
Carolina Queen	574	901	780	885	760	803	1086	1442	779	890
Dixie King	466	819	737	740	755	826	1171	1207	898	847
Stoneville 3202	617	893	688	912	710	808	1084	1143	740	844
Auburn M	586	709	720	883	743	869	1108	1179	734	837
Pennington HY-BEE	553	827	726	801	739	800	1005	1236	791	831
Auburn 56	621	763	670	845	659	873	1094	1143	803	830
Stoneville 7A	629	965	738	820	630	786	1014	1208	674	829
DeKalb 220	562	761	643	934	643	857	974	1266	809	828
Deltapine 45	550	882	755	890	568	783	972	1207	718	814
Empire WR 61	566	716	710	868	734	815	975	1054	761	800
Rex Smoothleaf	564	762	785	814	628	747	1015	1104	775	799
Deltapine SM. Lf.	610	818	715	842	570	747	936	1108	803	794
Coker 100A, WR	515	768	716	691	738	799	1012	1174	722	793
DeKalb 108	488	764	703	734	633	766	990	1169	719	774
Delfos 9169	475	706	554	725	705	784	1089	1131	737	767

State College

Cotton Varieties, 1964, Central Station, State College, Mississippi

Variety	Yield per A., lbs. Seed cotton	Yield per A., lbs. Lint	Dollar val. per A. SLM	Lint pct.	Staple 32nds inch	Bolls per lb. Seed cotton	Bolls per lb. Lint
Stoneville 213	1799	728	243	40.4	34.0	70	173
Stoneville 7A	1580	629	211	39.8	34.0	75	190
Auburn 56	1723	621	212	36.0	34.0	70	194
Stoneville 3202	1604	617	208	38.5	34.0	72	187
Deltapine Sm. Lf.	1537	610	204	39.6	34.0	78	196
Auburn M	1573	586	199	37.3	34.0	69	186
Carolina Queen	1488	574	193	38.5	34.0	69	180
Empire WR 61	1497	566	191	37.8	34.5	57	151
Rex Smoothleaf	1513	564	191	37.2	34.5	66	177
DeKalb 220	1499	562	190	37.5	34.0	66	177
Pennington HY-BEF	1453	553	184	38.0	33.5	65	172
Deltapine 45	1436	550	185	38.3	34.0	78	203
Coker 100A, WR	1364	515	174	37.7	34.5	70	186
DeKalb 108	1339	488	164	36.4	33.5	69	191
Deltos 9169	1371	475	176	34.6	35.0	63	183
Dixie King	1193	466	157	39.1	34.0	59	152
LSD @ 5%		117					
Cv		18.0%					

Soil: Verona fine sandy loam; Fertilizer: 75-50-50; Planted May 1; Poisoned 13 times.

Cotton Variety Averages, Central Station, State College, Mississippi.

Variety	Yield lint, pounds per acre 1960	1961	1962	1963	1964	Average	Averages Lint %	Percent first picking	Staple 32nd inch	Bolls per lb. seed cotton
Auburn 56	713	561	866	801	621	712	36.4	81	34.0	68
Deltapine Sm. Lf.	772	499	824	676	610	676	39.0	73	34.5	75
DeKalb 108	748	576	826	727	488	673	37.0	76	34.2	63
Stoneville 3202	741	562	754	687	617	672	38.3	79	33.6	71
Dixie King	756	490	830	806	466	670	38.1	79	34.1	56
Coker 100A, WR	748	559	789	713	515	665	37.9	71	34.4	68
Deltos 9169	853	485	749	611	475	635	35.2	67	35.1	60
Stoneville 213	—	502	839	740	728	—	—	—	—	—
DeKalb 220	—	533	795	847	562	—	—	—	—	—
Stoneville 7A	—	549	830	722	629	—	—	—	—	—
Carolina Queen	—	—	840	807	574	—	—	—	—	—
Auburn M	—	—	—	836	586	—	—	—	—	—
Rex Smooth Leaf	—	—	—	780	564	—	—	—	—	—
Empire WR. 61	—	—	—	711	566	—	—	—	—	—
Deltapine 45	—	—	—	574	550	—	—	—	—	—

Springs by the personnel of the North Mississippi Branch Station, Holly Springs, and one on bottom land on the Northeast Mississippi Branch Station, Verona.

High Yields

Every variety produced at the rate of more than two bales per acre in the bottom land test at Holly Springs and all but one produced more than two gross weight bales per acre in the test on the station farm at this location. Each of the 16 varieties produced essentially the same as the highest yielding one in at

Black Belt

Cotton Varieties, Black Belt Branch Station, Brooksville, Mississippi

Variety	Yield lint, pounds per acre 1960	1961	1962	1963	1964	Average	Averages Lint %	Percent first picking	Staple 32nd inch	Bolls per lb. seed cotton
Stoneville 3202	577	756	944	1136	893	861	39.6	61	33.4	82
Deltapine Sm. Lf.	590	600	1055	1238	818	860	40.3	60	34.2	85
Coker 100A, WR	616	710	961	1074	768	826	38.4	56	34.6	79
DeKalb 108	630	799	900	967	764	812	37.9	59	34.6	71
Dixie King	610	606	859	1094	819	798	39.6	62	34.1	65
Auburn 56	582	709	902	967	763	785	37.4	64	33.8	78
Delfos 9169	615	585	905	997	706	762	35.6	51	35.3	72
Stoneville 7A	—	588	1026	1185	965	—	—	—	—	—
DeKalb 220	—	745	1008	1132	761	—	—	—	—	—
Stoneville 213	—	—	1002	1227	928	—	—	—	—	—
Carolina Queen	—	—	999	1274	901	—	—	—	—	—
Deltapine 45	—	—	—	1166	882	—	—	—	—	—
Rex Smooth Leaf	—	—	—	845	762	—	—	—	—	—
Empire WR, 61	—	—	—	957	716	—	—	—	—	—
Auburn M	—	—	—	841	709	—	—	—	—	—

Cotton Varieties, 1964, Black Belt Branch Station, Brooksville, Mississippi.

Variety	Yield per A., lbs. Seed cotton	Lint	Dollar val. per A., SLM	Lint pct.	Staple 32nd inch	Bolls per pound Seed cotton	Lint	Pct. first picking
Stoneville 7A	2466	965	329	39.1	35.5	75	193	26
Stoneville 213	2346	928	316	39.5	35.0	73	186	32
Carolina Queen	2346	901	308	38.4	35.0	73	190	33
Stoneville 3202	2317	893	301	38.5	34.5	70	182	33
Deltapine 45	2248	882	300	39.2	35.0	76	193	35
Pennington HY-BEE	2210	827	289	37.4	36.0	69	186	37
Dixie King	2119	819	276	38.6	34.5	64	165	42
Deltapine Sm. Lf.	2142	818	280	38.2	35.0	78	204	36
Coker 100A, WR	2081	768	265	36.9	35.5	75	204	28
DeKalb 108	2063	764	263	37.0	35.5	68	184	34
Auburn 56	2117	763	260	36.0	34.5	72	201	42
Rex Smoothleaf	2090	762	263	36.4	35.5	62	172	43
DeKalb 220	2074	761	262	36.6	35.0	67	182	31
Empire WR 61	2032	716	253	35.2	36.0	60	170	43
Auburn M	1959	709	245	36.1	35.0	69	191	41
Delfos 9169	2105	706	252	33.5	36.0	69	206	21
LSD @ 5%		42.3						
Cv.		4.6%						

Soil: Houston Clay; Fertilizer: 90-60-60; Planted April 21; Poisoned 11 times.

least one test in 1964. These results indicate that all entries are good producers. However, some are better than others.

The ranking of varieties varied considerably from some stations to others. For this reason, the choice of a variety should be based largely on the test results at the station with conditions most nearly like your own. The averages tables should have more influence than the yearly tables as the relative performance of the varieties varies from year to year even in the same field. This is due to differences in weather, growing season, etc. The yearly tables must be studied for information other than yield on new varieties.

Brown Loam

Cotton Variety Averages, Brown Loam Branch Station, Raymond, Mississippi.

Variety	Yield lint, pounds per acre 1960	1962	1963	1964	Averages	Averages Lint %	Staple 32nds inch	Bolls per lb. seed cotton
Stoneville 3202	532	568	1150	912	790	39.5	32.2	78
Deltapine Sm. Lf.	575	543	1175	842	784	39.2	33.7	80
Auburn 56	474	650	1144	845	778	36.6	33.3	73
DeKalb 108	517	617	1143	734	753	37.2	33.4	68
Delfos 9169	465	451	1109	725	687	35.5	34.2	69
Dixie King	541	406	1053	740	685	37.3	33.5	60
Coker 100A, WR	490	511	888	691	645	37.6	33.7	77
Stoneville 213	—	698	1373	942	—	—	—	—
DeKalb 220	—	698	1182	934	—	—	—	—
Carolina Queen	—	587	1133	885	—	—	—	—
Stoneville 7A	—	692	1014	820	—	—	—	—
Empire WR, 61	—	—	1477	868	—	—	—	—
Deltapine 45	—	—	1120	890	—	—	—	—
Auburn M	—	—	1056	883	—	—	—	—
Rex Smooth Leaf	—	—	1052	814	—	—	—	—

Cotton Varieties, 1964, Brown Loam Branch Station, Raymond, Mississippi.

Variety	Yield per A., lbs. Seed cotton	Lint	Dollar val. per A. SLM	Lint pct.	Staple 32nds inch	Bolls per lb. Seed cotton	Lint
Stoneville 213	2540	942	324	37.0	35.0	70	191
DeKalb 220	2676	934	326	34.9	35.0	68	196
Stoneville 3202	2418	912	308	37.7	34.0	73	195
Deltapine 45	2406	890	302	37.0	34.5	72	196
Carolina Queen	2342	885	304	37.7	35.0	71	187
Auburn M	2532	883	308	34.8	35.0	67	192
Empire WR 61	2523	868	303	34.4	35.0	58	170
Auburn 56	2378	845	289	35.5	34.5	68	192
Deltapine Sm. Lf.	2329	842	287	36.1	34.0	78	217
Stoneville 7A	2244	820	279	36.5	34.5	70	192
Rex Smoothleaf	2318	814	283	35.1	35.0	65	185
Pennington HY-BEE	2251	801	274	35.6	34.5	70	196
Dixie King	2045	740	252	36.1	34.5	58	161
DeKalb 108	2115	734	256	34.6	35.0	64	186
Delfos 9169	2215	725	256	32.7	35.0	67	207
Coker 100A, WR	1953	691	240	35.3	35.0	74	211
LSD @ 5%		40.7					
Cv.		6.1%					

Soil: Grenada silt loam; Fertilizer: 98-65-65; Planted May 8; Poisoned 10 times.

Disease Resistance

Wilt resistant or tolerant varieties should be planted in fields where loss from wilt disease is considerable. Auburn 56, Auburn M, Coker 100A, and Carolina Queen have high resistance to Fusarium wilt and Dixie King, Empire, Rex Smoothleaf and DeKalb 108 are resistant. Deltapine 45, Auburn M, Auburn 56, Coker 100A, Stoneville 7A, Dixie King and Rex Smoothleaf have some tolerance to Verticillium wilt but none are classed as resistant.

Coastal Plain

Cotton Variety Averages, Coastal Plain Branch Station, Newton, Mississippi.

	Yield lint, pounds per acre						Averages			
Variety	1959	1960	1961	1963	1964	Average	Lint %	Percent first picking	Staple 32nd inch	Bolls per lb. seed cotton
Auburn 56	623	545	496	970	670	661	37.4	67	33.6	72
Dixie King	589	549	432	884	737	638	38.4	69	33.7	59
Delfos 9169	528	502	364	759	554	541	36.5	61	35.4	66
Stoneville 3202	585	516	459	927	688	635	39.3	70	33.2	77
Deltapine Sm. Lf.	586	492	472	878	715	629	39.7	63	34.0	81
Coker 100A, WR	566	502	441	955	716	636	38.8	66	34.4	72
DeKalb 108	—	535	473	858	703	—	—	—	—	—
DeKalb 220	—	—	492	977	643	—	—	—	—	—
Stoneville 7A	—	—	468	866	738	—	—	—	—	—
Carolina Queen	—	—	—	1038	780	—	—	—	—	—
Rex Smooth Leaf	—	—	—	967	785	—	—	—	—	—
Stoneville 213	—	—	—	955	762	—	—	—	—	—
Auburn M	—	—	—	965	720	—	—	—	—	—
Empire WR, 61	—	—	—	911	710	—	—	—	—	—
Deltapine 45	—	—	—	710	755	—	—	—	—	—

Cotton Varieties, 1964, Coastal Plain Branch Station, Newton, Mississippi.

	Yield per A., lbs.					Bolls per pound		
Variety	Seed cotton	Lint	Dollar val. per A., SLM	Lint pct.	Staple 32nd inch	Seed cotton	Lint	Pct. first picking
Rex Smoothleaf	2131	785	267	36.8	34.5	62	170	55
Carolina Queen	1970	780	265	39.6	35.0	68	171	43
Stoneville 213	1963	762	256	38.8	34.5	69	178	47
Deltapine 45	1960	755	254	38.5	34.5	73	189	47
Stoneville 7A	1894	738	252	38.9	35.0	73	188	44
Dixie King	1882	737	247	39.1	34.0	60	153	53
Pennington HY-BEE	1899	726	248	38.2	35.5	66	174	43
Auburn M	1979	720	245	36.4	34.5	68	186	55
Coker 100A, WR	1831	716	244	39.1	35.0	70	179	45
Deltapine Sm. Lf.	1921	715	246	37.2	35.0	81	217	48
Empire WR 61	1904	710	244	37.2	35.0	59	158	56
DeKalb 108	1862	703	238	37.7	34.5	68	181	47
Stoneville 3202	1728	688	230	39.8	34.5	73	183	50
Auburn 56	1880	670	229	35.6	34.5	73	205	47
DeKalb 220	1716	643	221	37.5	35.0	70	189	37
Delfos 9169	1594	554	196	34.8	36.5	65	188	34
LSD @ 5%		107.4						
Cv.		13.3%						

Soil: Prentiss fine sandy loam; Fertilizer: 72-72-72; Planted May 7; Poisoned 4 times.

The growing season as a whole was highly favorable to cotton as indicated by the record high statewide yield per acre. Excessive rain during early July at State College caused the plants at that location to become large and sappy with poor root systems. This was followed by a period of drouth. This combination of conditions plus the prolonged shading from the clouds accompanying the early July rains caused heavy shedding during the main boll setting period and consequently reduced yields.

Lint percentage, staple length, and boll size were not far from average.

North Mississippi, Bottom Land

Cotton Variety Averages, Bottom Land, North Missssissippi Branch Station, Holly Springs, Mississippi.

	Yield lint, pounds per acre					Averages			
Variety	1961	1962	1963	1964	Average	Lint %	Percent first picking	Staple, 32nds inch	Bolls per lb. seed cotton
DeKalb 220	1102	864	1012	1266	1051	37.1	71	35.5	61
Coker 100A, WR	1124	792	990	1174	1020	37.5	67	35.4	67
Stoneville 3202	1153	838	924	1143	1014	38.5	76	33.6	65
DeKalb 108	1116	809	913	1169	1002	36.5	69	34.8	61
Auburn 56	1113	811	939	1143	1001	36.5	71	34.5	64
Stoneville 7A	974	774	1009	1208	986	38.6	63	35.1	70
Dixie King	983	753	833	1207	944	37.0	69	35.1	56
Deltapine Sm. Lf.	970	743	951	1108	943	38.6	68	35.1	71
Delfos 9169	1010	672	892	1131	926	34.4	68	36.1	58
Stoneville 213	——	937	1087	1317	——	——	—	——	—
Carolina Queen	——	800	1067	1442	——	——	—	——	—
Deltapine 45	——	——	920	1207	——	——	—	——	—
Auburn M	——	——	918	1179	——	——	—	——	—
Rex Smooth Leaf	——	——	857	1104	——	——	—	——	—
Empire WR, 61	——	——	832	1054	——	——	—	——	—

Cotton Varieties, 1964, North Miss. Branch Station, Bottom Land, Holly Springs, Miss.

	Yield per A., lbs.					Bolls per pound		
Variety	Seed cotton	Lint	Dollar val. per A., SLM	Lint pct.	Staple 32nd inch	Seed cotton	Lint	Pct. first picking
Carolina Queen	3331	1442	476	43.2	34.5	66	152	61
Stoneville 213	3251	1317	433	40.5	33.5	73	181	67
DeKalb 220	3180	1266	424	39.8	34.5	65	165	65
Pennington HY-BEE	3094	1236	414	39.9	34.0	64	162	63
Stoneville 7A	2975	1208	403	40.6	34.0	74	183	60
Deltapine 45	3021	1207	398	39.9	33.5	69	172	65
Dixie King	2990	1207	397	40.3	33.5	62	154	64
Auburn M	3051	1179	391	38.6	33.5	63	165	72
Coker 100A, WR	2987	1174	394	39.3	34.0	78	199	60
DeKalb 108	2990	1169	393	39.1	34.0	72	184	62
Auburn 56	3026	1143	381	37.7	33.5	65	173	66
Stoneville 3202	2785	1143	375	41.0	33.0	70	172	71
Delfos 9169	3130	1131	391	36.1	35.0	60	166	58
Deltapine Sm. Lf.	2668	1108	368	41.5	34.0	72	175	64
Rex Smoothleaf	2854	1104	372	38.6	34.0	62	161	67
Empire WR, 61	2786	1054	351	37.8	33.0	56	149	62
LSD @ 5%		130.7						
Cv.		10.9%						

Soil: Collins; Fertilizer: 68-43-43; Planted May 4; Poisoned 12 times.

Single Row Plots

The plots were single rows which varied from 65 to 200 feet long and from 40 to 42 inches wide, being 42 at Brooksville only. Staple length, lint percentage, and boll size were determined from 100 boll samples. The staple length reported is the average of the determinations of two professional cotton classers each representing a different organization and stapling samples from different replications.

The price of the lint used in calculating the value per acre was the Government loan price at Starkville, Mississippi for Strict Low Middling cotton of the staple length of that variety in that test. Seed was valued at $49 per ton.

North Misissippi, Hill Land

Cotton Variety Averages, Hill Land, North Mississippi Branch Station, Holly Springs, Mississippi

	Yield lint, pounds per acre						Averages			
Variety	1960	1961	1962	1963	1964	Average	Lint %	Percent first picking	Staple 32nd inch	Bolls per lb. seed cotton
Auburn 56	779	867	785	779	1094	861	37.5	75	34.2	70
Dixie King	811	771	633	705	1171	818	38.0	66	34.0	61
Stoneville 3202	711	827	694	745	1084	812	39.5	78	33.1	73
Coker 100A, WR	755	811	726	750	1012	811	38.8	68	34.7	71
DeKalb 108	803	805	639	800	990	807	37.9	73	34.2	66
Delfos 9169	747	786	669	692	1089	797	36.6	62	35.1	66
Deltapine Sm. Lf.	713	858	503	685	936	739	39.0	71	33.9	77
Stoneville 7A	—	827	713	820	1014	—	—	—	—	—
DeKalb 220	—	813	723	804	974	—	—	—	—	—
Stoneville 213	—	—	766	788	1115	—	—	—	—	—
Carolina Queen	—	—	677	797	1086	—	—	—	—	—
Auburn M	—	—	—	845	1108	—	—	—	—	—
Rex Smooth Leaf	—	—	—	797	1015	—	—	—	—	—
Empire WR, 61	—	—	—	661	975	—	—	—	—	—
Deltapine 45	—	—	—	651	972	—	—	—	—	—

Cotton Varieties, Hill Land, North Miss. Branch Station, Holly Springs, Mississippi, 1964.

	Yield per A., lbs.					Bolls per pound		
Variety	Seed cotton	Lint	Dollar val. per A., SLM	Lint pct.	Staple 32nd inch	Seed cotton	Lint	Pct. first picking
Dixie King	2761	1171	382	42.4	33.5	74	175	42
Stoneville 213	2615	1115	348	42.6	31.5	78	183	50
Auburn M	2633	1108	362	42.1	33.5	72	171	53
Auburn 56	2725	1094	366	40.1	34.0	70	174	49
Delfos 9169	2673	1089	363	40.7	34.0	71	176	34
Carolina Queen	2579	1086	355	42.1	33.0	77	184	37
Stoneville 3202	2670	1084	356	40.6	33.0	67	165	55
Rex Smoothleaf	2446	1015	332	41.4	33.0	72	173	46
Stoneville 7A	2524	1014	334	40.1	33.0	69	173	41
Coker 100A, WR	2414	1012	336	41.9	34.0	70	167	40
Pennington HY-BEE	2634	1005	339	38.1	34.0	74	195	40
DeKalb 108	2446	990	326	40.4	33.5	70	174	41
Deltapine Sm. Lf.	2291	936	307	40.8	33.0	71	174	45
Empire WR 61	2326	975	323	41.9	34.0	74	177	42
DeKalb 220	2449	974	326	39.7	34.0	67	170	45
Deltapine 45	2374	972	319	40.9	33.0	68	168	41
LSD @ 5%		110.1						
Cv.		8.5%						

Soil: Grenada silt loam; Fertilizer: 72-48-48; Planted May 6; Poisoned 14 times.

The term LSD @ 5% means least significant difference. A difference in yield between varieties in a test of less than the figure indicated is not considered as a real difference but due to something other than the yielding ability of the varieties. Cv means coefficient of variation and the smaller it is the more reliable the test.

Northeast Mississippi

Cotton Variety Averages, Northeast Mississippi Branch Station, Verona, Mississippi

	Yield lint, pounds per acre					Averages		
Variety	1959	1962	1963	1964	Averages	Lint %	Staple 32nds inch	Bolls per lb. seed cotton
Stoneville 3202	1255	927	596	740	879	38.2	33.9	72
Dixie King	1162	912	439	898	853	37.1	34.7	55
Auburn 56	1164	736	551	803	813	36.3	34.7	68
Deltapine Sm. Lf.	1059	878	489	803	807	39.9	34.6	74
Coker 100A, WR	1156	810	434	722	780	37.1	35.6	68
Delfos 9169	1129	807	368	737	760	34.9	36.3	63
Stoneville 213	—	966	499	773	—	—	—	—
DeKalb 220	—	848	554	809	—	—	—	—
Stoneville 7A	—	946	587	674	—	—	—	—
Carolina Queen	—	900	430	779	—	—	—	—
DeKalb 108	—	825	453	719	—	—	—	—
Empire WR, 61	—	—	489	761	—	—	—	—
Deltapine 45	—	—	503	718	—	—	—	—
Rex Smooth Leaf	—	—	389	775	—	—	—	—
Auburn M	—	—	403	734	—	—	—	—

Cotton Varieties, 1964, Northeast Mississippi Branch Station, Verona, Mississippi

	Yield per A., lbs.					Bolls per lb.	
Variety	Seed cotton	Lint	Dollar val. per A. SLM	Lint pct.	Staple 32nds inch	Seed cotton	Lint
Dixie King	2417	898	305	37.1	34.0	53	144
DeKalb 220	2248	809	280	35.9	35.0	62	172
Auburn 56	2242	803	274	35.8	34.0	64	180
Deltapine Sm. Lf.	1982	803	268	40.5	34.0	71	176
Pennington HY-BEE	2143	791	269	36.9	34.5	62	169
Carolina Queen	2059	779	267	37.8	35.0	63	168
Rex Smooth Leaf	2207	775	266	35.1	34.0	61	174
Stoneville 213	2130	773	263	36.2	34.0	70	194
Empire WR 61	2199	761	266	34.6	35.0	56	162
Stoneville 3202	1989	740	247	37.2	33.5	67	181
Delfos 9169	2216	737	263	33.2	36.0	61	184
Auburn M	1919	734	247	38.2	34.5	61	161
Coker 100A, WR	2004	722	250	36.0	35.5	66	184
DeKalb 108	2035	719	250	35.3	35.5	62	176
Deltapine 45	1953	718	244	36.7	34.0	68	185
Stoneville 7A	1814	674	229	37.2	34.5	68	182
LSD @ 5%		52.2					
Cv		6.0%					

Soil: Bottom; Fertilizer: 66-92-60; Planted May 14; Poisoned 5 times.

Pontotoc, Flatwoods

Cotton Variety Averages, Flatwoods, Pontotoc Ridge-Flatwoods Branch Station, Pontotoc Mississippi.

	Lint yield, pounds per acre						Averages		
Variety	1960	1961	1962	1963	1964	Average	Lint %	Staple 32nds inch	Bolls per lb. seed cotton
Dixie King	505	738	512	787	755	659	38.1	33.4	59
Coker 100A, WR	466	853	470	691	738	644	38.3	33.8	72
Stoneville 3202	448	818	513	697	710	637	39.7	32.5	77
Auburn 56	491	766	535	710	659	632	37.3	33.5	72
DeKalb 108	499	790	527	695	633	629	37.7	34.0	66
Deltapine Sm. Lf.	495	721	436	668	570	578	39.4	33.3	80
Delfos 9169	408	627	449	597	705	557	36.1	35.0	64
DeKalb 220	—	784	487	799	643	—	—	—	—
Stoneville 7A	—	701	494	693	630	—	—	—	—
Carolina Queen	—	—	528	789	760	—	—	—	—
Stoneville 213	—	—	526	777	708	—	—	—	—
Auburn M	—	—	—	752	743	—	—	—	—
Empire WR, 61	—	—	—	727	734	—	—	—	—
Rex Smooth Leaf	—	—	—	718	628	—	—	—	—
Deltapine 45	—	—	—	719	568	—	—	—	—

Cotton Varieties, 1964, Flatwoods, Pontotoc-Ridge-Flatwoods Br. Station, Pontotoc, Miss.

	Yield per A., lbs.					Bolls per lb.	
Variety	Seed cotton	Lint	Dollar val. per A. SLM	Lint pct.	Staple 32nds inch	Seed cotton	Lint
Carolina Queen	1920	760	255	39.5	34.5	69	175
Dixie King	1976	755	251	38.2	33.5	64	167
Auburn M	1970	743	248	37.7	33.5	68	181
Pennington HY-BEE	1933	739	249	38.2	34.5	66	173
Coker 100A, WR	1941	738	245	38.0	33.5	74	195
Empire WR 61	1927	734	244	38.0	33.5	59	157
Stoneville 3202	1821	710	235	38.9	33.0	76	196
Stoneville 213	1879	708	236	37.6	33.5	78	207
Delfos 9169	1990	705	241	35.4	34.5	65	183
Auburn 56	1758	659	223	37.5	34.0	73	196
DeKalb 220	1723	643	215	37.3	33.5	68	182
DeKalb 108	1702	633	211	37.2	33.5	71	190
Stoneville 7A	1667	630	210	37.8	33.5	76	201
Rex Smoothleaf	1711	628	210	36.7	33.5	64	174
Deltapine Sm. Ll.	1471	570	189	38.7	33.0	82	212
Deltapine 45	1539	568	193	36.9	34.5	77	210
LSD @ 5%		120.6					
Cv.		14.1%					

Soil: Bude; Fertilizer: 76-60-60; Planted May 11; Poisoned 6 times.

Pontotoc, Ridge

Cotton Variety Averages, Pontotoc Ridge, Pontotoc Ridge-Flatwoods Branch Station, Pontotoc, Mississippi.

	Lint yield, pounds per acre						Averages		
Variety	1960	1961	1962	1963	1964	Average	Lint %	Staple 32nds inch	Bolls per lb. seed cotton
Auburn 56	566	1010	648	939	873	807	36.8	34.2	68
Coker 100A, WR	534	1066	578	991	799	794	38.5	34.5	70
Stoneville 3202	603	986	553	988	808	788	38.7	33.3	75
DeKalb 108	530	1014	667	939	766	783	37.8	34.3	63
Dixie King	549	959	590	944	826	774	38.0	34.2	57
Deltapine Sm. Lf.	569	928	593	843	747	736	39.4	34.3	78
Delfos 9169	449	742	574	784	784	667	35.9	35.1	63
DeKalb 220	----	994	681	888	857	----	----	----	—
Stoneville 7A	----	1007	639	894	786	----	----	----	—
Carolina Queen	----	----	700	1056	803	----	----	----	—
Stoneville 213	----	----	695	919	831	----	----	----	—
Auburn M	----	----	----	1039	869	----	----	----	—
Deltapine 45	----	----	----	913	783	----	----	----	—
Rex Smooth Leaf	----	----	----	949	747	----	----	----	—
Empire WR, 61	----	----	----	854	815	----	----	----	—

Cotton Varieties, 1964, Pontotoc Ridge, Pontotoc Ridge-Flatwoods Br. Station, Pontotoc, Miss.

	Yield per A., lbs.					Bolls per lb.	
Variety	Seed cotton	Lint	Dollar val. per A. SLM	Lint pct.	Staple 32nds inch	Seed cotton	Lint
Auburn 56	2392	873	293	36.5	33.5	68	188
Auburn M	2286	869	289	38.0	33.5	70	184
DeKalb 220	2297	857	291	37.3	34.0	66	178
Stoneville 213	2154	831	276	38.5	33.5	77	202
Dixie King	2123	826	278	38.9	34.5	60	154
Empire WR 61	2167	815	276	37.6	34.0	58	155
Stoneville 3202	2073	808	268	38.9	33.5	79	203
Carolina Queen	2092	803	271	38.3	34.5	70	183
Pennington HY-BEE	2123	800	267	37.6	33.5	69	184
Coker 100A, WR	2065	799	269	38.7	34.5	75	195
Stoneville 7A	2014	786	264	39.0	34.5	75	192
Delfos 9669	2228	784	269	35.2	34.5	61	175
Deltapine 45	2077	783	265	37.6	34.0	74	198
DeKalb 108	2056	766	263	37.2	35.0	67	182
Deltapine Sm. Lf.	1925	747	251	38.8	34.0	80	207
Rex Smoothleaf	2048	747	254	36.5	34.5	64	176
LSD @ 5%		65.0					
Cv.		6.1%					

Soil: Atwood sand loam; Fertilizer: 76-60-60; Planted May 4; Poisoned 9 times.

ORIGINAL SOURCE OF SEED

Auburn 56—Alabama Agricultural Experiment Station, Auburn, Alabama.

Auburn M—Foundation Seed Stocks, Columbia, Missouri.

Coker 100A, WR and Carolina Queen—Coker's Pedigreed Seed Co., Hartsville, S. C.

DeKalb 108 and 220—DeKalb Agricultural Assn., Inc., Bogart, Georgia.

Deltapine 45 and Smooth Leaf—Delta & Pine Land Co., Scott, Mississippi.

Empire WR 61—Empire Pedigreed Seed Co., Haralson, Georgia.

Rex Smoothleaf—Cotton Branch Experiment Station, Marianna, Arkansas.

Stoneville 213; 7A; Delfos 9169 and Dixie King—Stoneville Pedigreed Seed Co., Stoneville, Mississippi.

Pennington HY-BEE—Cotton Hybrid Research, Inc., Athens, Georgia.

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Soil Fumigation Increases Strawberry Yields

By J. P. OVERCASH and
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Summary

At State College tests were conducted with four preplant soil fumigants to determine their effect on subsequent growth and plant survival. Vapam, Mylone and Allyl Alcohol had favorable results: excellent weed control the first spring; increased runner plant formation; and increased yields over non treated plots.

At Holly Springs, Mylone fumigated plots were compared with non treated plots of four varieties. The results from soil fumigation included: control of weeds the first spring; better plant production and survival up to 3 years (especially with the Earlidawn variety); higher yields than check plots; and later ripening. The differences in varieties were: Earlidawn and Blakemore fruits ripened early in the season, whereas, the Massey and Pocahontas varieties ripened late. Yields in descending order from the highest were: Pocahontas, Earlidawn, Blakemore, and Massey. Earlidawn was greater in yield than Blakemore only in fumigated plots.

SOIL FUMIGATION INCREASES STRAWBERRY YIELDS

By J. P. OVERCASH[1] and S. P. CROCKETT[2]

In central and north Mississippi strawberry growers often have difficulty obtaining adequate runner formation. This results in poor stands of plants and often the yields are unprofitable. An ideal plant stand would be a solid bed of plants 24 to 30 inches wide for each row.

Several factors may contribute to poor runner formation and plant survival. Summer droughts often associated with prolonged high temperatures are not favorable for strawberry plant growth. Many varieties thrive best at 75° F and growth is seriously retarded above 95° F. Soil borne diseases, such as red stele (**Phytophthora fragaria,** Hickman) often attack strawberry roots and impair their effectivenss to support growth. Furthermore, insects and root knot nematodes (**Meloidogyne hapla,** Chitwood) also feed on strawberry roots and weaken the plants.

Because strawberry plants have a very shallow root system weeds are serious competitors for nutrients and water. This competition is especially serious until the newly set plants become well established.

With the advent of a large number of chemical soil fumigants and their successful use in commercial production of many crops it appeared desirable to determine if any of these fumigants might influence strawberry plant survival and runner formation. Fumigants may be of a highly specialized nature such as Nemagon for the control of nematodes or they may be of the broad spectrum type such as Vapam which may kill several soil borne organism as well as control many weeds.

One experiment was planned at State College with four fumigant treatments. Another experiment was conducted at the North Mississippi Branch Station at Holly Springs with one broad spectrum fumigant and four varieties.

Materials and Methods

At State College a site was selected in a field in which strawberries had been grown for several years. Most of the plants died during a summer drought the year preceding this experiment.

The soil was thoroughly pulverized to a depth of 6 inches. Surface water drainage was diverted around the area. A 5 x 5 latin square experiment was arranged with 4 chemical pre-plant fumigation treatments and a check. The area was marked off into 4 x 4 foot plots with 3-foot alleys between all plots. The alleys were sloped to be about 3 inches lower than the plots. Water falling on the plots drained in either of two directions. Water runoff from one plot did not flood onto other plots. The alley drains were kept open throughout the experiment.

The fumigation treatments were applied in November 1958, and the plots were set in March 1959. A stock of virus-free, Blakemore strawberry plants was obtained from a commercial nursery. Plants set in the plots were produced from runners of the virus-free mother plants in a bed in a lath house. They were rooted in 3 inch pots of soil which had been fumigated with Mylone. Nine plants were set in each pot and spaced 12" apart.

The fumigants were furnished gratis by the following companies: DuPont—Vapam; Shell Chemical—Allyl Alcohol and Nemagon; Union Carbide Chemicals—Mylone.

The rates of application per 49 square feet (including 1½ feet of alley around each plot) were Allyl Alcohol 7/8 pint: Mylone (85W) ½ pound; Vapam (32-

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[1] Horticulture Department, State College.

[2] North Mississippi Branch Station, Superintendent, Holly Springs.

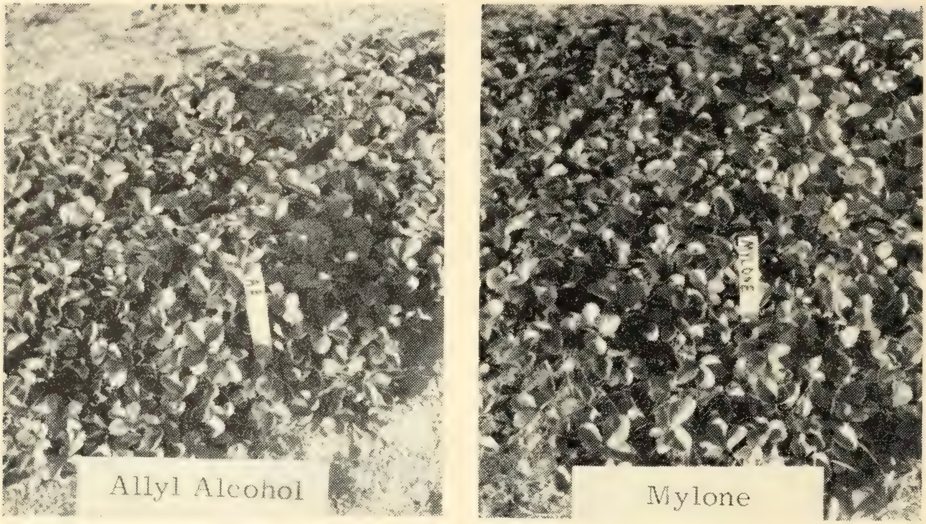
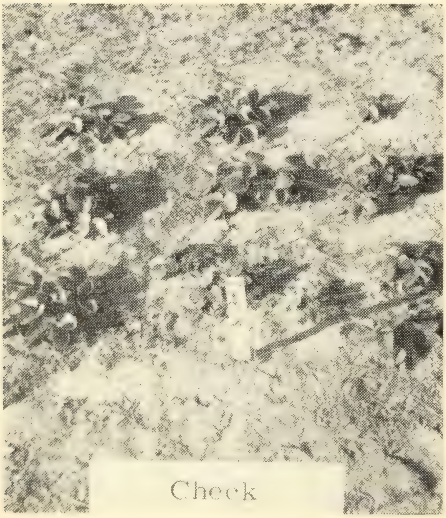


Figure 1. Preplant soil fumigation with Allyl Alcohol, Mylone and Vapam resulted in excellent plant growth after one season. Plots treated with Nemagon and untreated check plots had few runner plants formed.

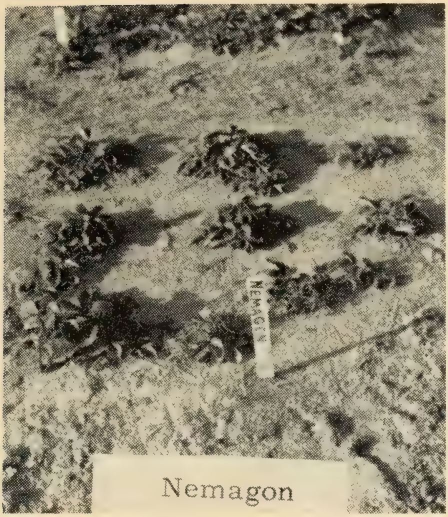


.7%) 1½ pints; and Nemagon (10% granules) ½ pound. Each material was diluted in 3 gallons of water and applied to the plot and then "watered in" with 7 gallons of water. Within 24 hours after the treatments were applied a rainfall of 2½ inches was recorded.

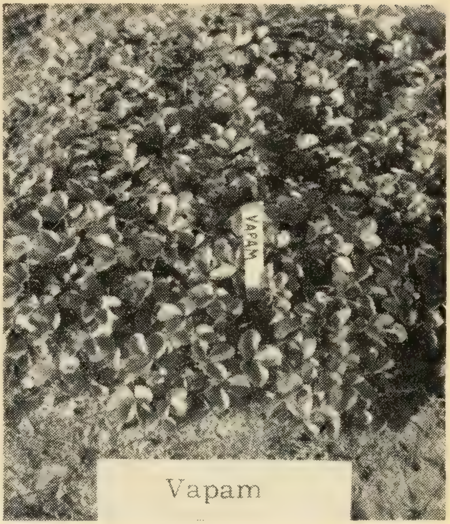
Weed counts were made during the first summer and plant counts were made at the end of the growing season. Total yields were recorded for two seasons.

At Holly Springs the fumigation site was selected in an old strawberry field on the Experiment Station in which many plants had died during the summer droughts the preceding summer. The plots were 6 x6 with 4-foot alleys between all plots. Surface water drainage from adjacent land was diverted around the test area and the alleys were about 3 inches lower than the plots. All drains from the plots were kept open to prevent flooding of plots.

Mylone was applied as a 50D formulation from W. H. Barber Co. at the rate of .85 pounds actual per 10 x 10 foot area (included 2 feet of alley around plot). The chemical was "watered in" with 10 gallons of water in November 1959. The treatments were arranged in four randomized replicates. Sixteen virus-free



Nemagon



Vapam

plants, from a commercial nursery, were spaced 18" apart in each plot in March 1960. The number of plants per plot and total yield of fruit was recorded annually.

Results

At State College the first evident result was the effectiveness of Vapam, Mylone and Allyl Alcohol for weed control during the winter and spring, extending into early summer, see Table 1. In June when weed counts were made there were very few weeds in these plots (4 to 6 per square foot) whereas, the check and Nemagon plots averaged 70 and 88 weeds per square foot. The few weeds which did grow in the Vapam, Mylone and Allyl Alcohol plots were large and therefore, the total weight was large. These weeds could have been easily controlled by hand weeding in April or May.

The second effect of the broad spectrum fumigants was marked increase in the number of runner plants which were formed and rooted, Figure 1. The Vapam, Mylone and Allyl Alcohol plots had three times as many plants at the end of the first growing season as the check or Nemagon plots, Table 2.

Table 1. The influence of application of soil fumigants before setting strawberries on subsequent weed growth. Plants set in March and weeds were recorded in June 1959 at State College, Mississippi.

Soil treatment	No. weeds per square foot	Pounds weeds per plot
None	70	6.1
Allyl Alcohol	4	3.8
Mylone	6	8.2
Nemagon	88	6.7
Vapam	5	5.2

Table 2. The influence of an application of soil fumigants before setting on subsequent growth of strawberry plants of the Blakemore variety at State College, Mississippi.

Soil treated	Number of plants per plot one year after setting
None	31
Allyl Alcohol	122
Mylone	139
Nemagon	37
Vapam	116

Berries were harvested 2 or 3 times per week during the fruiting seasons of 1960 and 1961. Total yields per plot were recorded in grams and are shown in Table 3. Each year the yields from the Vapam, Mylone and Allyl Alcohol plots were significantly greater than from the check or Nemagon plots.

At Holly Springs the first results observed was the effectiveness of Mylone in controlling weeds through the spring following the application of the chemical in the fall.

Four varieties of strawberries were included in this test with a known history of excellent to poor stands of plants at the North Mississippi Branch Experiment Station where these test were conducted. Earlidawn had previously given the poorest record of runner plant formation and survival. Soil borne pests were suspected as being the limiting factor for good survival and growth for this variety at Holly Springs.

Table 3. The influence of an application of soil fumigants before setting on the yield of Blakemore strawberry plants at State College, Mississippi. Plants set in March 1959.

Soil Treatment	Yields in grams per plot 1960	1961	Average
None	1674	3216	2445
Allyl Alcohol	3224	3511	3367
Mylone	3942	3769	3855
Nemagon	1844	2472	2158
Vapam	3948	3710	3829

Plant counts were made in each plot during the dormant season for each year, Table 4. Each year the Earlidawn plots which were treated with Mylone as a preplant treatment had about twice as many plants as Earlidawn plots which received no soil treatment. The most pronounced effects on plant stands were evident after the third growing season. The Mylone treated plots of all varieties had significantly more plants than the plots which received no soil treatment. The soil fumigation treatment had a long lasting effect on plant survival in all varieties. However, it was most pronounced for the variety Earlidawn, which ordinarily is a weak plant producer.

The berries were harvested 2 to 3 times each week during each fruiting season. Total yields were recorded in grams per plot and the summary is shown in Table 5. The largest increase in yield was shown by the Earlidawn variety in Mylone plots. The average yield for three years was more than twice that for the check plots of this variety. During the third fruiting season the yields from Mylone treated plots of all varieties were significantly larger than the check plots.

Table 4. Influence of soil fumigation before setting the plants on number of plants per plot of four varieties of strawberries at Holly Springs, Mississippi.

Variety	Soil Treatment	Number of plants per plot 1961	1962	1963	Average
Blakemore	None	90	136	94	107
Blakemore	Mylone	40	80	184	101
Earlidawn	None	26	68	58	51
Earlidawn	Mylone	47	107	172	109
Massey	None	39	102	196	112
Massey	Mylone	34	108	260	134
Pocahontas	None	67	154	150	124
Pocahontas	Mylone	52	137	214	134
	Summary by varieties				
Blakemore		65	108	139	104
Earlidawn		37	87	115	80
Massey		36	105	228	123
Pocahontas		59	145	182	129
	Summary by treatment				
	None	56	115	124	98
	Mylone	43	108	207	119

Strawberry yields are often closely related to the number of plants in the plot or bed. This correlation is upset however, when the number of plants per square foot becomes so large that plant competition for nutrients and moisture is severe.

Each fruiting season the variety Pocahontas produced more berries than any other variety. The three-year average yield for all Pocahontas plots was twice as great as for all Earlidawn. However, the average yield for 3 years for Earlidawn from all Mylone plots was about two thirds as large as Pocahontas yields from Mylone plots.

The berries on plants in the Mylone treated plots ripened later than berries on plants in check plots. Table 6, Earlidawn is the earliest variety to ripen followed by Blakemore. Massey and Pocahontas produced only about one third of their fruits during the first half of the harvest season and are normally classed as late ripening varieties.

Table 5. Influence of soil fumigation before setting the plants on subsequent yields of four varieties of strawberries at Holly Springs, Mississippi.

Variety	Soil treatment	Grams of fruit per plot 1961	1962	1963	Average
Blakemore	Check	3325	1452	1368	2048
Blakemore	Mylone	1647	1529	3434	2203
Earlidawn	Check	1640	1762	1616	1672
Earlidawn	Mylone	2888	3259	4069	3405
Massey	Check	940	888	1962	1263
Massey	Mylone	1046	834	2344	1408
Pocahontas	Check	6268	3576	4970	4938
Pocahontas	Mylone	6001	3092	6403	5165
		Summary by varieties			
Blakemore		2486	1491	2401	2126
Earlidawn		2264	2493	2843	2533
Massey		993	861	2153	1336
Pocahontas		6135	3334	5688	5052
		Summary by treatments			
	Check	3043	1910	2480	2475
	Mylone	2895	2178	4062	3045

Table 6. Influence of soil fumigation before setting the plants on earliness of ripening of fruits of four varieties of strawberries at Holly Springs, Mississippi.

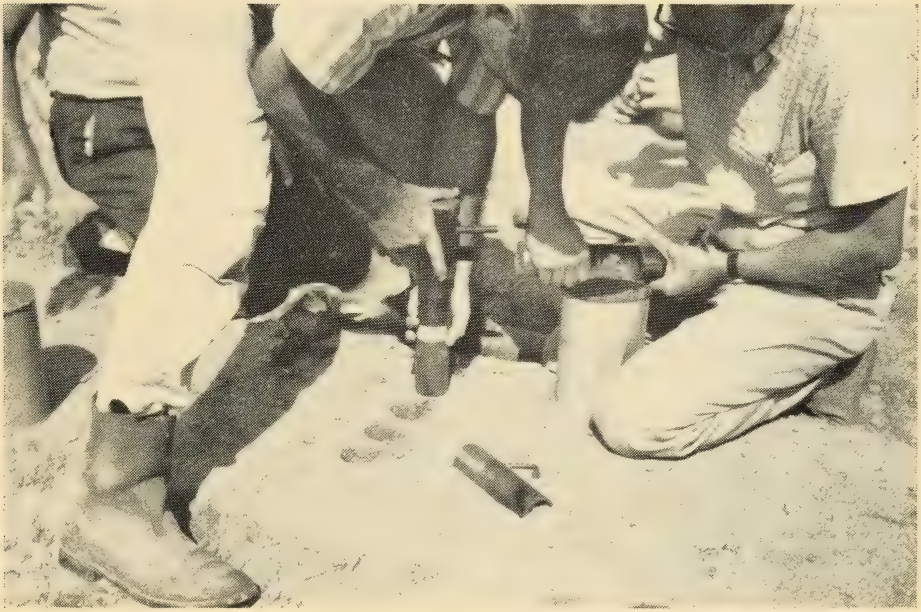
Variety	Soil treatment	Percent of yield in first half of season 1961	1962	1963	Average
Blakemore	None	71	64	66	67
Blakemore	Mylone	61	51	56	56
Earlidawn	None	81	72	71	75
Earlidawn	Mylone	69	71	64	68
Massey	None	38	42	25	35
Massey	Mylone	17	43	28	29
Pocahontas	None	46	37	36	40
Pocahontas	Mylone	28	40	25	31
		Summary by varieties			
Blakemore		66	57	61	61
Earlidawn		75	71	71	72
Massey		28	42	27	32
Pocahontas		37	33	30	33
		Summary by treatment			
	None	59	54	51	55
	Mylone	44	48	43	45

BULLETIN 702 MARCH 1965

A Progress Report on the

Evaluation Of Soil Incorporators

—Dye Techniques



BY W. L. BARRENTINE,
O. B. WOOTEN, AND
J. T. HOLSTUN, JR.

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On the Cover

Figure 1. Vertical soil cores being removed for laboratory analysis of dye content by fluorometer.

EVALUATION OF SOIL-INCORPORATORS—DYE TECHNIQUES

BY W. L. BARRENTINE, O. B. WOOTEN, AND J. T. HOLSTUN, JR.[1]

Development of trifluralin[2] and granular formulations of CIPC requiring soil-incorporation for effective weed control has been closely associated with the availability of implements designed specifically for soil-incorporation.

Both trifluralin and granular CIPC are currently recommended by the Mississippi Weed Committee for pre-emergence use on limited cotton acreage. To obtain effective weed control and remain within the tolerance limits of the cotton plant, the 1965 recommendations give the depths to which trifluralin should be incorporated as ½ to 1 inch ~~and ½ inch~~ and CIPC granules ½ inch.

Because of the increasing importance of soil-incorporation and the increasing availability of implements, a study was begun at the Delta Branch Experiment Station in 1964 to develop techniques for evaluating soil-incorporators. The objective of the first phase was to determine quantitatively, the depth and uniformity of incorporation provided by incorporators in current farm use.

Materials and Methods

This study was conducted on a Bosket very fine sandy loam having a soil moisture of 15 percent. Both ground-driven and power-driven (PTO) types were evaluated including the following:

1. Ground-driven — open steel mesh wheel; 2-gang rotary hoe, full floating; lawnmower reel gauged by a mesh wheel less the chain drive; and 2-gang rotary hoe with the rear section driving the front section by chain linkage at a ratio of 2 to 1.
2. Power-driven — PTO tillage units with L-shaped blades.[3]

A tank mixture of 25 ml of 40 percent Rhodamine B dye per gallon of water was applied to an 18-inch band at a broadcast rate of 40 gallons per acre. Four standard or check samples were taken before incorporation from left to right at 2-inch intervals across the band with a 2-inch soil tube. Theoretically, the total amount of dye applied to a given 2-inch diameter surface area was contained within each sample.

The various implements were then used at the maximum depth possible to incorporate the dye and the soil rolled to give a smooth surface. All ground-driven implements were rear mounted on the same tractor and were run at a ground speed of 4 MPH.

Four soil cores, three inches deep, two inches in diameter, spaced two inches apart, were taken across the incorporated band (Figure 1). Each core was divided into depth increments of 0 to 0.5, 0.5 to 1, 1 to 2, and 2 to 3 inches. This sampling procedure was repeated at two additional locations approximately 10 feet apart down the row. The dye was extracted from the soil with methanol and the concentration determined by fluorometric methods.

Results and Discussion

The percentage of the surface applied dye at depths of 0 to 0.5, 0.5 to 1, 1 to 2, and 2 to 3 inches in each core taken across the band at three sample sites after incorporation is shown in Figures 2, 3, 4, and 5. The failure for any one column (or core) to equal 100 percent is attributed to the movement of the dye to or from areas adjacent to the sample core by the incorporator.

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[1] Research Associate, Delta Branch, Mississippi Agricultural Experiment Station; Agricultural Engineer, Agricultural Engineering Research Division, and Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, respectively, at Stoneville, Mississippi.

[2] Trifluralin is alpha, alpha, alpha,-trifluoro-2, 6-dinitro-N, N-dipropyl-p-toluidine. CIPC is isopropyl N-(3-chlorophenyl) carbamate.

[3] Gandy Row Wheel, Chem-N-Soil Mixer, Yellow Devil, Mix-A-Product, and Bye-Hoe, respectively. Mention or omission of any trade name implies neither endorsement or criticism by either the U. S. Department of Agriculture or the Mississippi Agricultural Experiment Station. Trade names are given solely for purposes of identification.

The open mesh wheel incorporated the dye largely in the top ½ inch of soil with a greater incorporation on the left side of the band (Figure 2). The depth of incorporation obtained was shallow as expected due to its design and construction. Though alignment was closely checked, improper alignment of the device over the band may account for the greater concentration at the ½ inch depth in the cores taken from the left side of the band. If the row wheel was off-set to the right, the left cores may have contained dye that failed to be incorporated. A shifting of the dye could have also occurred if the row wheel was

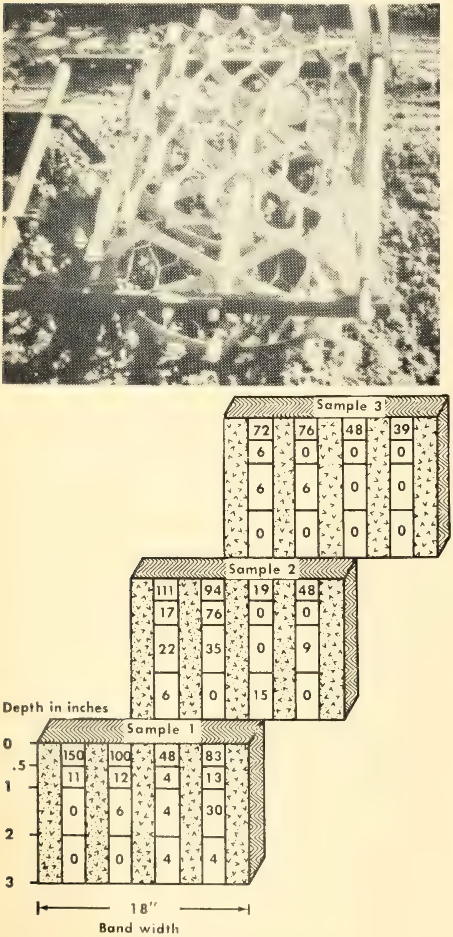

Sample 3
72
76
48
39
6
0
0
0
6
6
0
0
0
0
0
0
Sample 2
111
94
19
48
17
76
0
0
22
35
0
9
6
0
15
0
Depth in inches
Sample 1
0
.5
1
2
3
150
100
48
83
11
12
4
13
0
6
4
30
0
0
4
4
18"
Band width

Figure 2. Ground driven open steel mesh wheel.

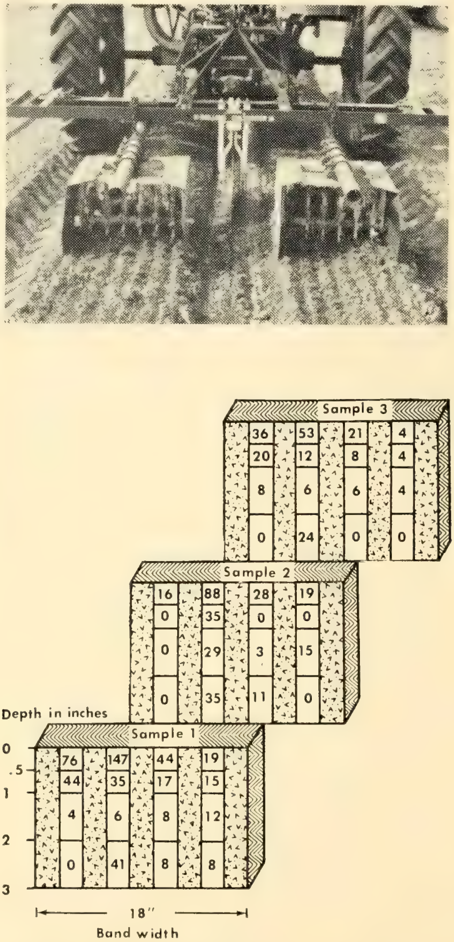
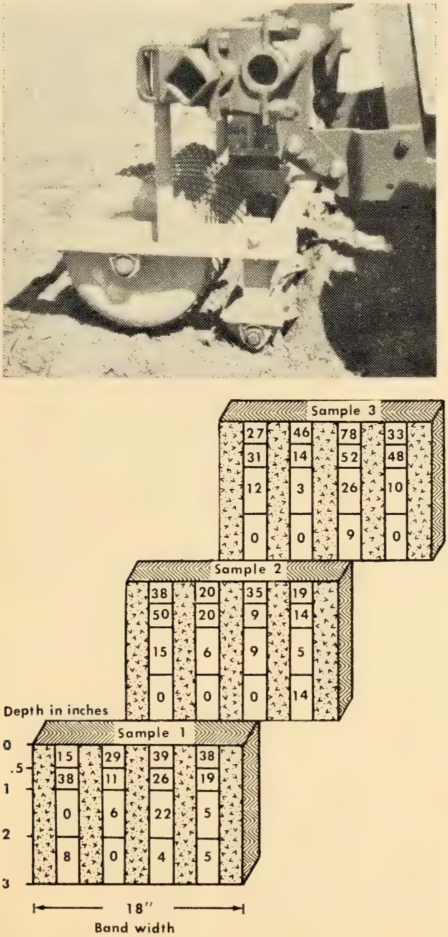

Sample 3
36
53
21
4
20
12
8
4
8
6
6
4
0
24
0
0
Sample 2
16
88
28
19
0
35
0
0
0
29
3
15
0
35
11
0
Depth in inches
Sample 1
0
.5
1
2
3
76
147
44
19
44
35
17
15
4
6
8
12
0
41
8
8
18"
Band width

Figure 3. Ground driven rotary hoe.

set at a slight angle to the right when used. However, this might be a characteristic pattern as these factors were held to a minimum.

An incorporation pattern similar to that of the row wheel was obtained with the full floating rotary hoe (Figure 3). A higher concentration was present on the left side of the band to the one-inch depth. However, within the second column from the left a higher concentration was present at the 2 to 3 inch depth than at the 0.5 to 1 and 1 to 2 inch depths. The same factors that may have affected the open mesh wheel pattern may have been involved in this case, but a close check was also maintained when this device was used.

Figure 4 shows a relatively uniform pattern of incorporation to a depth of 1 inch that was obtained with the lawnmower reel device. Less variability was present across the incorporated band in either the 0 to 0.5 or 0.5 to 1 inch



Sample 3

27	46	78	33
31	14	52	48
12	3	26	10
0	0	9	0

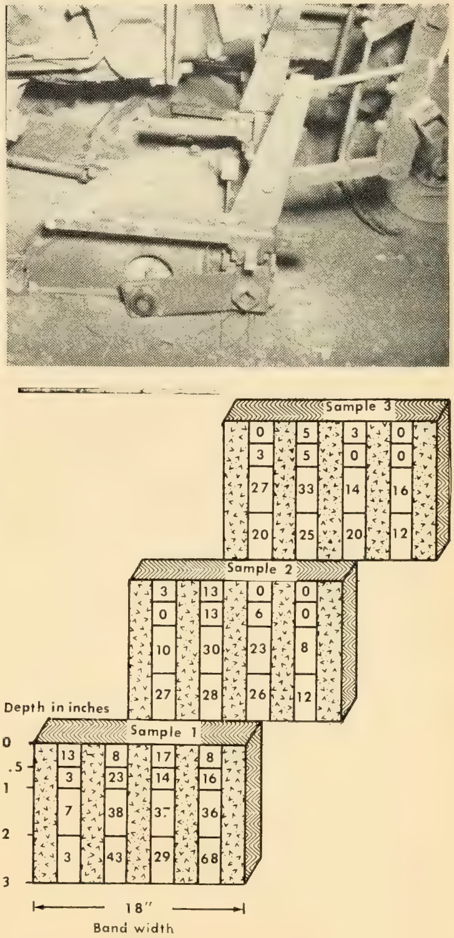
Sample 2

38	20	35	19
50	20	9	14
15	6	9	5
0	0	0	14

Sample 1

15	29	39	38
38	11	26	19
0	6	22	5
8	0	4	5

Figure 4. Ground driven lawnmower reel device.



Sample 3

0	5	3	0
3	5	0	0
27	33	14	16
20	25	20	12

Sample 2

3	13	0	0
0	13	6	0
10	30	23	8
27	28	26	12

Sample 1

13	8	17	8
3	23	14	16
7	38	37	36
3	43	29	68

Figure 5. Power driven unit.

depths than that of the open steel mesh wheel or the rotary hoe. This was also true between the 0 to 0.5 and 0.5 to 1 inch depths within each core.

No satisfactory results were obtained using the 2-gang, chain linkage rotary hoe. With the soil conditions of this study, the drag on the rear driving section slowed the front section resulting in an accumulation of soil between the rotary tines and complete stoppage of both hoe sections.

At the ground speed of 4 MPH, the power-driven (PTO tillage units gave an inversion of the dye treated soil (Figure 5). Untreated soil was brought to the surface inch and the dye treated surface soil was placed at depths of 1 to 3 inches. A more uniform pattern might have been obtained with a slower tractor ground speed. The PTO drive was at maximum rpm so no attempt to obtain a more uniform pattern was possible by increasing the 360 rpm of the tillage units.

During the course of this study, it was noted that the depth of dye incorporation obtained by the ground-driven implements was somewhat less than the depth of operation. For this reason the authors wish to stress that the incorporation of a herbicide to a specific depth may require operating at a greater depth, depending upon the implement used.

Realizing that some incorporation is necessary to obtain effective weed control with trifluralin or granular CIPC because of volatilization and the requirement of soil moisture for activation, horizontal uniformity is perhaps as important as verticle uniformity. Without uniform incorporation, there is the possibility of having "blank" areas within the treated band which may allow weeds to emerge.

When run in the floating position, depths not more than 1 to 1½ inches should be expected from the full floating rotary hoe or the lawnmower reel device, and not more than ½ inch from the open mesh wheel with conditions similar to those of this study. For depths greater than 1 to 1½ inches, the power-driven (PTO) type implements are required, though depths greater than 1 to 1½ inches are not recommended by the Mississippi Weed Committee because of possible crop injury. Regardless of the implement used, one should give particular attention to proper alignment when mounting and while using. If the device is offset, tilted or running at an angle to the treated band, the herbicide will likely be deposited in streaks of high and low concentrations, shifted to one side, or thrown off the row.

This work is being expanded to devise more precise techniques and include evaluation of devices such as disc harrows, bed-conditioners, and other implements that are being used for incorporation of herbicides. It is hoped that the information gathered will not only be of value to the farmer and research worker, but will also provide a method of measurement which manufacturers can use to design better soil-incorporators and which chemical formulators can use to determine the degree of incorporation needed.

BULLETIN 703 MARCH 1965

Calibration Tables For Power Sprayers

BY O. B. WOOTEN AND
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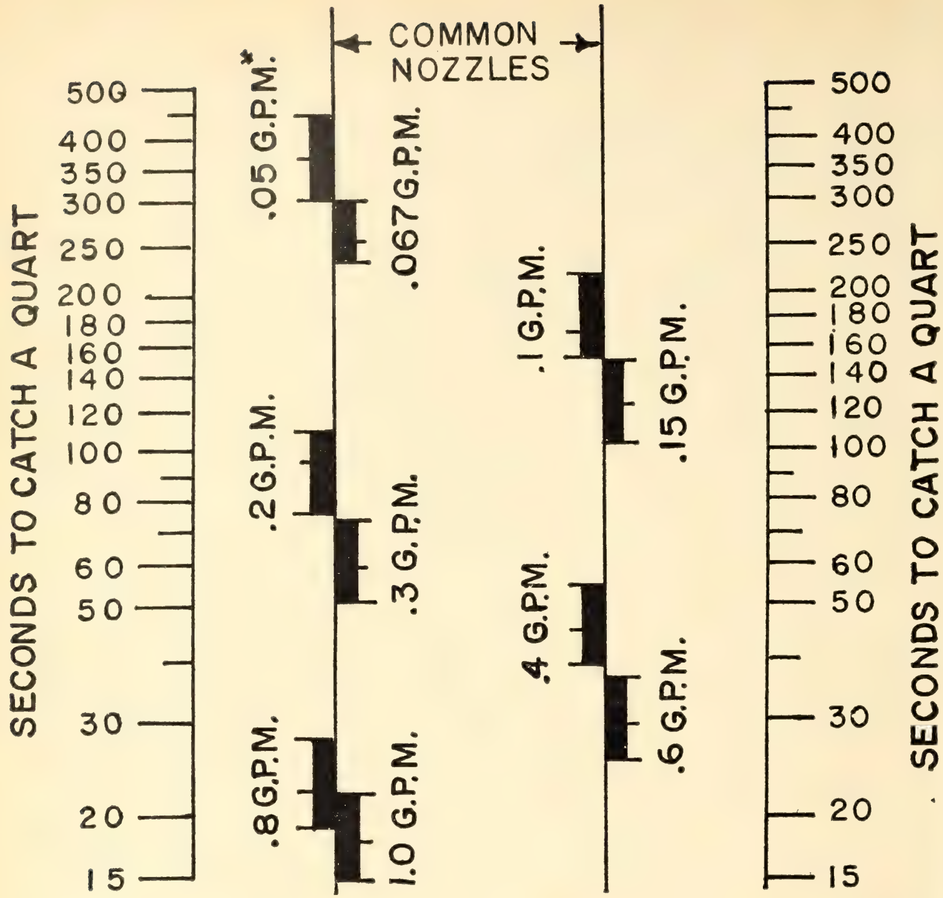

Figure 1.—Nozzle Selection Chart.

Manufacturers designate size of nozzles in different ways, but all of them provide flow data in gallons per minute (G.P.M.) at specified pressures. The above designations (ie., 0.05 to 1.0) are the rated deliveries in gallons per minute at 40 p.s.i. On each broad bar are 3 short lines. The top lines indicate the delivery at 20 p.s.i., the middle line at 30 p.s.i., and the bottom line at 40 p.s.i.

Example of Use: You need a nozzle which will deliver 1 quart in 100 seconds. Lay a straight edge from 100 sec./qt. on the left to 100 sec./qt. on the right. Intersection of the broad bar between the 20 and 30 p.s.i. lines of the 0.2 gal./min. nozzle indicated you will need a nozzle rated to deliver 0.2 gal./min. at 40 p.s.i., **and** that **your** spraying pressure should lie between 26 and 29 p.s.i.

CALIBRATION TABLES FOR POWER SPRAYERS

BY O. B. WOOTEN AND J. T. HOLSTUN, JR.[1]

Safe, effective use of herbicides to control weeds in crop land demands accurate calibration of the application equipment. An underdose will not control the weeds; an overdose is wasteful. Even more important, an overdose may kill your crop and result in accumulation of toxic residues in the soil.

Accurate calibration can be fast and easy. The tables presented will cover most of the herbicide applications for power sprayers.

Calibrating knapsack sprayers and granular distributors, including calibration and mixing formulas will be published in a subsequent bulletin.

Calibration Procedure

Calibration of power sprayers involves selection of the right combination of nozzle type, nozzle orifice size, number of nozzles, nozzle placement, spraying pressure, and sprayer speed for the rate of application desired.

There are many ways in which the right combination can be selected. A practical method is to:

1. Determine the rate of application to be used, and which type of nozzle is appropriate for the application, that is, wide or narrow spray angle, even distribution or regular distribution, etc.

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[1] Agricultural Engineer, Agricultural Engineering Research Division, and Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, respectively.

Cooperative investigation of Agricultural Engineering Research Division and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Delta Branch, Mississippi Agricultural Experiment Station, Stoneville, and is a contribution to Regional Cotton Mechanization Project S-2.

Table 1. Number of seconds required for delivery of 1 quart from 1 nozzle when a sprayer at a specified speed is applying a specified volume per 13068 row feet of a band of any width from 1 nozzle per row.[1]

Speed		Gallons/13068 row feet from 1 nozzle						
MPH	Seconds per 300 feet	6	10	12	14	16	18	20
		Seconds per quart						
2.2	93	169	101	84	72	63	56	51
2.4	85	155	93	77	66	58	52	46
2.6	79	143	86	71	61	54	48	43
2.8	73	133	80	66	57	50	44	40
3.0	68	124	74	62	53	46	41	37
3.2	64	116	70	58	50	44	39	35
3.4	60	109	66	55	47	41	36	33
3.6	57	103	62	52	44	39	34	31
3.8	54	98	59	49	42	37	33	29
4.0	51	93	56	46	40	35	31	28
4.2	49	88	53	44	38	33	29	26
4.4	46	84	51	42	36	32	28	25
4.6	44	81	48	40	35	30	27	24
4.8	43	77	46	39	33	29	26	23
5.0	41	74	45	37	32	28	25	22
5.2	39	71	43	36	31	27	24	21
5.4	38	69	41	34	30	26	23	21
5.6	37	66	40	33	28	25	22	20
5.8	35	64	38	32	27	24	21	19
6.0	34	62	37	31	26	23	21	19
7.0	29	53	32	26	23	20	18	16

[1] Use primarily for calibration of band-type sprayers having 1 nozzle per row.

Table 3. Number of seconds required for delivery of 1 quart from one nozzle when

Nozzle spacing (inches)	Rate of applic. (Gal./A)		SPRAYER SPEED (MPH) 1.0	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4
40	5	Seconds per quart	446	223	202	186	172	159	149	139	131
	10		223	112	101	93	86	80	74	70	66
	15		148	74	67	62	57	53	49	46	44
	20		111	56	50	46	43	40	37	35	33
	25		89	45	40	37	34	32	30	28	26
	30		74	37	34	31	28	26	25	23	22
	35		64	32	29	27	25	23	21	20	
	40		56	28	25	23	22	20			
20	5	Seconds per quart	892	446	405	372	343	318	297	278	262
	10		446	223	202	186	172	159	149	139	131
	15		296	148	134	123	114	106	99	92	87
	20		222	111	101	93	85	79	74	69	65
	25		178	89	81	74	69	64	59	56	52
	30		148	74	67	62	57	53	49	46	44
	35		128	64	58	53	49	46	43	40	38
	40		112	56	51	47	43	40	37	35	33
10	5	Seconds per quart	1784	892	810	744	687	637	594	557	524
	10		892	446	405	372	343	318	297	278	262
	15		592	296	269	247	228	211	197	185	174
	20		444	222	202	185	171	159	148	139	131
	25		356	178	162	148	137	127	119	111	105
	30		296	148	134	123	114	106	99	92	87
	35		256	128	116	107	99	91	85	80	75
	40		224	112	102	93	86	80	75	70	66
38	5	Seconds per quart	469	235	213	196	181	167	156	146	138
	10		234	117	106	98	90	84	78	73	69
	15		156	78	71	65	60	56	52	49	46
	20		117	59	53	49	45	42	39	37	34
	25		94	47	43	39	36	34	31	29	29
	30		78	39	35	33	30	28	26	24	23
	35		67	34	30	28	26	24	22	21	20
	40		59	30	27	25	23	21	20		
19	5	Seconds per quart	938	469	426	391	361	335	312	293	276
	10		468	234	212	195	180	167	156	146	138
	15		312	156	142	130	120	111	104	97	92
	20		234	117	106	98	90	84	78	73	69
	25		188	94	85	78	72	67	63	59	55
	30		156	78	71	65	60	56	52	49	46
	35		134	67	61	56	52	48	45	42	39
	40		118	59	54	49	45	42	39	37	35
9½	5	Seconds per quart	1876	938	852	782	722	670	625	585	552
	10		936	468	425	390	360	334	312	292	275
	15		624	312	283	260	240	223	208	195	183
	20		468	234	212	195	180	167	156	146	138
	25		376	188	171	157	145	134	125	117	111
	30		312	156	142	130	120	111	104	97	92
	35		268	134	122	112	103	96	89	84	79
	40		236	118	107	98	91	84	79	74	69

sprayer is delivering a specified volume per acre at a specified speed and nozzle spacing.

	SPRAYER SPEED (MPH)										
.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.5	6.0	7.0	8.0
4	117	112	106	101	97	93	89	81	74	64	56
2	59	56	53	51	48	46	45	41	37	32	28
1	39	37	35	34	32	31	30	27	25	21	
1	29	28	26	25	24	23	22	20			
5	23	22	21	20							
1											
8	235	223	212	202	194	186	178	162	149	128	112
4	117	112	106	101	97	93	89	81	74	64	56
2	78	74	70	67	64	62	59	54	49	42	37
2	58	56	53	50	48	46	44	40	37	32	28
9	47	45	42	40	39	37	36	32	30	25	22
1	39	37	35	34	32	31	30	27	25	21	
6	34	32	30	29	28	27	26	23	21		
1	29	28	27	25	24	23	22	20			
6	469	446	425	405	387	371	357	325	298	255	223
8	235	223	212	202	194	186	178	162	149	128	112
5	156	148	141	134	128	123	118	108	99	85	74
3	117	111	106	101	96	92	89	81	74	63	56
9	94	89	85	81	77	74	71	65	59	51	44
2	78	74	70	67	64	62	59	54	49	42	37
1	67	64	61	58	56	53	51	47	43	37	32
2	59	56	53	51	49	47	45	41	37	32	28
0	123	117	112	106	102	98	94	85	78	67	59
5	62	59	56	53	51	49	47	43	39	33	29
3	41	39	37	35	34	32	31	28	26	22	20
3	31	29	28	27	25	24	23	21	20		
6	25	24	22	21	20	20					
2	21	20									
1	247	235	223	213	204	195	188	171	157	134	117
0	123	117	111	106	102	97	94	85	78	67	59
7	82	78	74	71	68	65	62	57	52	45	39
5	62	59	56	53	51	49	47	43	39	33	29
2	49	47	45	43	41	39	38	34	31	27	24
3	41	39	37	35	34	32	31	28	26	22	20
7	35	34	32	30	29	28	27	24	22		
3	31	30	28	27	26	25	24	21	20		
2	493	469	446	426	407	390	375	341	313	268	235
0	246	234	223	212	203	195	187	170	156	134	117
3	164	156	149	142	135	130	125	114	104	89	78
0	123	117	111	106	102	97	94	85	78	67	59
5	99	94	89	85	82	78	75	68	63	54	47
7	82	78	74	71	68	65	62	57	52	45	39
5	70	67	64	61	58	56	54	49	45	38	34
6	62	59	56	54	51	49	47	43	39	34	30

Table 2. Number of seconds required for delivery of 1 quart from 1 nozzle when a sprayer at a specified speed is applying a specified volume per 13068 row feet of a band of any width from 2 nozzles per row.[1]

Speed			Gallons/13068 row feet from 2 nozzles										
MPH	Seconds per 300 feet		4	5	6	7	8	10	12	14	16	18	20
2.2	93	Seconds per quart	506	405	338	289	253	202	169	145	127	112	101
2.4	85		464	371	309	265	232	186	155	133	116	103	93
2.6	79		428	343	286	245	214	171	143	122	107	95	86
2.8	73		398	318	265	227	199	159	133	114	99	88	80
3.0	68		371	297	248	212	186	148	124	106	93	82	74
3.2	64		348	278	232	199	174	139	116	99	87	77	70
3.4	60		328	262	218	187	164	131	109	94	82	73	66
3.6	57		309	248	206	177	155	124	103	88	77	69	62
3.8	54		293	234	195	167	147	117	98	84	73	65	59
4.0	51		278	223	186	159	139	111	93	80	70	62	56
4.2	49		265	212	177	152	133	106	88	76	66	59	53
4.4	46		253	202	169	145	127	101	84	72	63	56	51
4.6	44		242	194	161	138	121	97	81	69	61	54	4[illegible]
4.8	43		232	186	155	133	116	93	77	66	58	52	46
5.0	41		223	178	149	127	111	89	74	64	56	49	45
5.2	39		214	171	143	122	107	86	71	61	54	48	43
5.4	38		206	165	138	118	103	82	69	59	52	46	41
5.6	37		199	159	133	114	99	80	66	57	50	44	40
5.8	35		192	154	128	110	96	77	64	55	48	43	38
6.0	34		186	149	124	106	93	74	62	53	46	41	37
7.0	29		159	127	106	91	80	64	53	45	40	35	32

---

[1] Use primarily for calibration of band-type postemergence sprayers having 2 nozzles per row (or for 4 nozzles per row where only the two inside or drill-spraying nozzles are to be calibrated)

2. Select a convenient gear and throttle setting for operation of the sprayer. Then determine the speed of the sprayer in this gear and throttle setting by timing the number of seconds it takes the sprayer to travel 300 feet under field operating conditions. Be sure that sprayer is operating at full speed before it enters the marked course of 300 feet. A stop watch marked in minutes and seconds and a 100-foot tape are necessary to do a good job of calibration. If permanent markers can be set for the beginning and end points of the 300-foot course, it will make future calibrations easier. Speed may be converted to miles per hour by reference to table 1 or 2. If your sprayer is equipped with speedometer, you should use the above procedure to check its accuracy from time to time.

3. Use tables 1-4 to determine the spray delivery requirement for each nozzle in seconds per quart for the selected rate of application and the determined rate of speed. Table 1 applies to band spraying with 1 nozzle per row, while table 2 applies to band spraying with 2 nozzles per row. Both tables 1 and 2 are expressed in gallons per 13,068 feet of row. This procedure is used because many growers have 40-inch rows and 13,068 feet of 40-inch row equals 1 acre. This is inconvenient for other row widths only when computing the amount of herbicide needed to treat a given acreage. The volumes expressed may be applied to any desired band width.

Table 3 is for broadcast spraying, and covers collectively 6 common nozzle spacings. The calibration information for **broadcast** spraying is expressed in familiar gallons-per-acre terms.

4. Use figures 5 to select the nozzles having the right size orifice. This figure can be used also to determine the approximate spraying pressure.

5. Install the nozzles in the sprayer and adjust the spraying pressure until each nozzle delivers 1 quart in the number of seconds determined in step 3 above.

6. Adjust the spacing direction and height of all nozzles to give the desired placement of spray. This step is listed last because it frequently is difficult to catch the spray material from the nozzles in the proper spraying position.

Bulletin 704 March 1965

Normal Yields And Production Practices By Soil Types, Mississippi Brown Loam Area

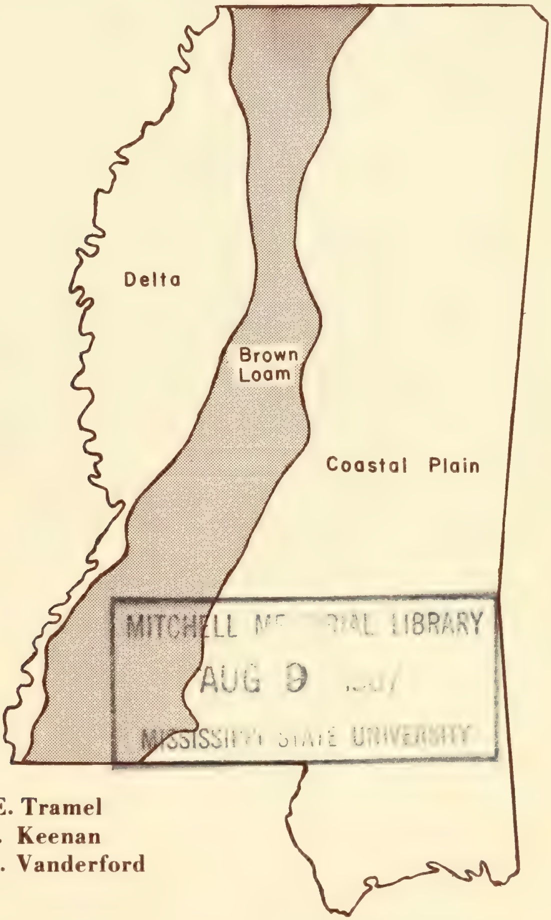

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Table 2. CORN: Normal yield per acre by productivity groups and level of nitrogen applied, Mississippi Brown Loam Area, 1965 3

NORMAL YIELDS AND PRODUCTION PRACTICES BY SOIL TYPES MISSISSIPPI BROWN LOAM AREA

By

THOMAS E. TRAMEL, WALTER E. KEENAN, and
HARVEY B. VANDERFORD

The Brown Loam Area of Mississippi is an extension of the Southern Loess Belt, which extends from the Ohio River southward to the State of Louisiana. It borders the Mississippi Delta on the east and gradually merges with the Coastal Plain forming a strip of land thirty five to seventy miles wide from the Northern to the Southern boundary of the State.

Soils of the Brown Loam Area developed from loess or windblown material which varies in thickness from three to sixty feet. This material is silty and the most uniform soil-forming material found in Mississippi. Soils on level and gently sloping relief that develop from loess material are well suited for many crops and respond well to good management practices. Many of the soils have fragipans (hardpans) at various depths in the profiles. Where the topography is sloping or steep, these soils also are easily eroded when cultivated. In general, however, the soils of the Brown Loam Area have high productive capacities when used for crops or pastures.

Soil productivity is governed to a great extent by the properties of the soil profile and the associated landscape features. In soil survey work, scientists group soils of somewhat similar characteristics into "soil mapping units." The different soil mapping units are made up of different combinations of soil type, slope, and degrees of erosion. A given field may be made up of only one or of several soil mapping units. In this study the soil mapping units, as recorded on soil maps of the Brown Loam Area, were used as the basis for collecting data for the various crops.

Because of the large number of soil mapping units in the area, it was impossible to obtain data for each one. Hence data were obtained only for those which make up a large part of the agricultural land of the area.[1] Soil mapping units for which data were obtained were organized into five productivity groups as indicated below.[2]

Soil Mapping Units Studied, By Productivity Groups--

Dry sloping and eroded land.

Atwood silt loam	C3
Grenada silt loam	C3
Loring silt loam	C3
Loring silty clay loam	C3
Memphis silt loam	C3
Providence silt loam	C3

Deep moderately well drained upland and bench soils.--

Atwood silt loam	B3
Grenada silt loam	A1
Grenada silt loam	B2
Grenada silt loam	B3
Loring silt loam	B2
Loring silt loam	B3
Memphis silt loam	A1
Memphis silt loam	B1 and B2
Memphis silt loam	B3
Memphis and Loring silt loam	B2 and B3
Providence silt loam	B2
Providence silt loam	B3
Richland silt loam	A1 and A2

---

[1] See Appendix A for sampling procedures.

[2] Symbols following the soil names describe the slope or lay of the land and erosion conditions. A denotes 0-2 percent slope; B, 2-5; and C 5-8. Erosion conditions are denoted by + for accumulation, 1 for none to slight, 2 for moderate, and 3 for severe.

Richland silt loam	B2
Dulac silt loam	B3

Somewhat poorly drained upland and bench soils.

Bude silt loam	A+ and A1
Bude silt loam	B1 and B2
Calloway silt loam	A+ and A1
Calloway silt loam	B1 and B2
Falkner silt loam	B2
Hatchie silt loam	A1
Olivier silt loam	A+ and A1
Olivier silt loam	B1 and B2

Deep moderately well drained bottom land.

Adler silt loam	A1
Vicksburg silt loam	A+ and A1
Morganfield silt loam	A+
Collins silt loam	A+
Collins silt loam	A1, A+
Collins silt loam	A1, B+, and B1
Collins silty clay loam	A+
Falaya silt loam	A+ and A1
Falaya silt loam	A1, A+
Falaya silt loam	A1, B+
Inglefield silt loam	A+
Hymon soils	

Low wet land.

Almo silt loam	A1
Henry silt loam	A+ and A1
Calhoun silt loam	A+ and A1
Urbo silt loam	A+
Waverly silt loam	A+

In addition to other uses, soil classification based upon physical characteristics is quite valuable for farm planning. However, the usefulness of soil classification for this purpose is dependent to a large extent upon a knowledge of yields and production practices associated with each classification. This study was made to provide estimates of normal yields and normal production practices for the most important soil mapping units of the Brown Loam Area of Mississippi. Data for the study were obtained by personal interview with a sample of farmers in the Brown Loam Area.

Generally, for data obtained by personal interview to yield reliable averages, a relatively large number of observations is required. Thus results are reported only for situations for which ten or more observations were obtained.

While results of the study are presented for individual soil mapping units, a broader grouping of soils is generally adequate for farm planning purposes. In addition, grouping several soil mapping units together increases the number of observations upon which the figures are based and, consequently, the reliability of the figures. Hence results are also presented for the five productivity groups indicated above.

Yield is influenced by the level of management used in production. Thus, for comparing yields for two different soil mapping units, it would be desirable to have the same level of management for each. Since this was impossible in this study, care must be exercised in interpreting differences in yield for the different soil mapping units.

Many different factors are involved in specifying a "level of management" and no completely satisfactory method of measuring it has been devised. Timing of the different production practices as well as the level is important. However, in the production of cotton and corn, the principal crops of the area, it would seem reasonable to assume that overall level of management would be highly correlated with the amount of nitrogen applied. Thus the level of nitrogen applied can be used as a rough indication of the level of managment. Differences in yield for different levels of applied nitrogen should not then all be attributed to the difference in nitrogen applied. Instead they should be attributed to differences in overall level of management which includes all production practices as well as timing of these practices. Hence these comparisons must be made in terms of the overall level of management associated with the different levels of nitrogen applied.

Results for cotton and corn for the five productivity groups are presented for three levels of nitrogen applied (40 pounds or less, 41-60 pounds, and 61 pounds or more). While it would have been desirable to present results for the individual soil mapping units in this manner, the number of observations was not adequate.

Normal yields and normal production practices are presented in Appendix B for cotton, corn, and soybeans for situations for which ten or more observations were obtained. For quick reference, yields are summarized in Tables 1 and 2 for cotton and corn for the three levels of nitrogen.

Cotton

Both soils and management are important in determining yields (Table 1.) By reading downward in the table we see the variations in average yields that can be attributed to soil differences. By reading across we see yield differences attributable to differences in management (as measured by the levels of nitrogen applied).

When only small quantities of nitrogen were applied yields from "dry sloping hill soils" were lower than those from any other soils group. But with heavier applications of nitro-

Table 1. COTTON: Normal yield[1] per acre by productivity groups and level of nitrogen applied, Mississippi Brown Loam Area, 1965.

Productivity group[2]	Applied Nitrogen		
	40 lbs. or less	41-60 lbs.	61 lbs. or more
	Lbs. of lint per acre		
Dry sloping hill soils	385	501	615
Deep moderately well drained upland and bench soils	415	507	602
Somewhat poorly drained upland and bench soils	406	487	550
Deep moderately well drained bottom soils	557	623	691
Low wet soils	485	___	___

[1] For production practices see Appendix Table 39-51.

[2] For individual soil mapping units and averages for productivity groups see Appendix Tables 1-38.

Table 2. CORN: Normal yield[1] per acre by productivity groups and level of nitrogen applied, Mississippi Brown Loam Area, 1965.

Productivity group[2]	Applied Nitrogen		
	40 lbs. or less	41-60 lbs.	61 lbs. or more
	Bu. per acre		
Dry sloping hill soils	25	36	54
Deep moderately well drained upland and bench soils	26	41	55
Somewhat poorly drained upland and bench soils	30	44	57
Deep moderately well drained bottom soils	38	54	67
Low wet soils	32	44	52

[1] For production practices see Appendix Tables 86-100.

[2] For individual soil mapping units and averages for productivity groups see Appendix Tables 52-85.

gen these soils gave greater yields than did the "somewhat poorly drained upland and bench soils."

Corn

As was the case with cotton, corn yields are seen to be dependent upon both soils and management (Table 2). Average yields varied from a low of 25 bushels per acre for the low level of nitrogen on "dry sloping hill soils" to a high of 67 bushels per acre for the high level of nitrogen on "deep moderately well drained bottom soils."

Soybeans

Soybean yields and production practices were obtained in sufficient number to report for only three productivity groups. Yields averaged 23, 24, and 27 bushels, respectively, for "deep moderately well drained upland and bench soils," "somewhat poorly drained upland and bench soils," and "deep moderately well drained bottom soils" (Appendix Tables 106-108).

Appendix A

All completed soil maps of the area, each covering approximately four square miles, were studied and labeled with the predominant soil mapping unit. All soil mapping units for which it was felt that at least ten observations could be obtained for one or more crops were then selected for study.

For each soil mapping unit selected for study, all soils maps labeled as representing predominantly soils of the particular classification were arrayed by the flight numbers appearing on the aerial photograph. From this array, study maps were selected in a systematic manner to insure "spreading" of the study maps over the entire Brown Loam Area.

An enumerator visited each farm located on the study maps and obtained, for each soil mapping unit represented on the farm, data relative to crops grown, normal yields, and normal production practices.

LIST OF APPENDIX TABLES

Normal yield per acre and production practices for various crops and soils in the Mississippi Brown Loam Area, 1965.

Table	Crop	Soil	Page
1	Cotton	Adler silt loam, A+	7
2	"	Atwood silt loam, C3	7
3	"	Bude silt loam, B1 and B2	8
4	"	Calloway silt loam, B1 and B2	8
5	"	Collins silt loam, A+ and A1	8
6	"	Collins silt loam, 1.a. and A+	9
7	"	Collins silt loam, 1.a., B+, and B1	9
8	"	Dulac silt loam, B3	9
9	"	Falaya silt loam, A+ and A1	10
10	"	Falaya silt loam, 1.a. and A+	10
11	"	Falaya silt loam, 1.a. and B+	11
12	"	Falkner silt loam, B2	11
13	"	Grenada silt loam, A1	11
14	"	Grenada silt loam, B2	12
15	"	Grenada silt loam, B3	12
16	"	Grenada silt loam, C3	13
17	"	Hatchie silt loam, A1	13
18	"	Loring silt loam, B2	13

Table	Crop	Soil	Page
19	"	Loring silt loam, B3	14
20	"	Loring silt loam, C3	14
21	"	Loring silty clay loam, C3	14
22	"	Memphis silt loam, A1	15
23	"	Memphis silt loam, B1 and B2	15
24	"	Memphis silt loam, B3	15
25	"	Memphis silt loam, C3	16
26	"	Memphis and Loring silt loam, B2 and B3	16
27	"	Olivier silt loam, A+ and A1	16
28	"	Olivier silt loam, B1 and B2	17
29	"	Providence silt loam, B2	17
30	"	Providence silt loam, B3	17
31	"	Providence silt loam, C3	18
32	"	Richland silt loam, A1 and A2	18
33	"	Richland silt loam, B2	18
34	"	All dry sloping hill soils	19
35	"	All deep moderately well drained upland and bench soils.	19
36	"	All somewhat poorly drained upland and bench soils	20
37	"	All deep moderately sell drained bottom soils	20
38	"	All Low Wet Soils	21
39	"	Dry sloping hill soils with 40 pounds or less of nitrogen applied	21
40	"	Dry sloping hill soils with 41-60 pounds of nitrogen applied	21
41	"	Dry sloping hill soils with 61 pounds or more of nitrogen applied	22
42	"	Deep moderately well drained upland and bench soils with 40 pounds or less of nitrogen applied	22
43	"	Deep moderately well drained upland and bench soils with 41-60 pounds of nitrogen applied	22
44	Cotton	Deep moderately well drained upland and bench soils with 61 pounds or more of nitrogen applied	23
45	"	Somewhat poorly drained upland and bench soils with 40 pounds or less of nitrogen applied.	23
46	"	Somewhat poorly drained upland and bench soils with 41-60 pounds of nitrogen applied	24
47	"	Somewhat poorly drained upland and bench soils with 61 pounds or more of nitrogen applied	24
48	"	Deep moderately well drained bottom soils with 40 pounds or less of nitrogen applied	25
49	"	Deep moderately well drained bottom soils with 41-60 pounds of nitrogen applied	25
50	"	Deep moderately well drained bottom soils with 61 pounds or more of nitrogen applied	26
51	"	Low wet soils with 40 pounds or less of nitrogen applied	26
52	Corn	Adler silt loam, A+	26
53	"	Atwood silt loam, C3	27
54	"	Bude silt loam, B1 and B2	27
55	"	Calloway silt loam, A+ and A1	27
56	"	Calloway silt loam, B1 and B2	28
57	"	Collins silt loam, A+ and A1	28
58	"	Collins silt loam, 1.a. and A+	28
59	"	Collins silt loam, 1.a., B+, and B1	29
60	"	Dulac silt loam, B3	29

Table	Crop	Soil	Page
61	"	Falaya silt loam, A+ and A1	29
62	"	Falaya silt loam, 1.a. and A+	30
63	"	Falaya silt loam, 1.a. and B+	30
64	"	Falkner silt loam, B2	30
65	"	Grenada silt loam, A1	31
66	"	Grenada silt loam, B2	31
67	"	Grenada silt loam, B3	31
68	"	Grenada silt loam, C3	32
69	"	Hatchie silt loam, A1	32
70	"	Inglefield silt loam, A+	32
71	"	Loring silt loam, B2	33
72	"	Loring silt loam, B3	33
73	"	Loring silt loam, C3	33
74	"	Loring silty clay loam, C3	34
75	"	Memphis silt loam, A1	34
76	"	Memphis silt loam, B1 and B2	34
77	"	Memphis silt loam, B3	35
78	"	Memphis silt loam, C3	35
79	"	Memphis and Loring silt loam, B2 and B3	35
80	"	Providence silt loam, B2	36
81	"	Providence silt loam, B3	36
82	"	Providence silt loam, C3	36
83	"	Richland silt loam, A1 and A2	37
84	"	Richland silt loam, B2	37
85	"	Urbo silty clay loam, A+	37
86	"	Dry sloping hill soils with 40 pounds or less of nitrogen applied	38
87	"	Dry sloping hill soils with 41-60 pounds of nitrogen applied	38
88	Corn	Dry sloping hill soils with 61 pounds or more of nitrogen applied	38
89	"	Deep moderately well drained upland and bench soils with 40 pounds or less of nitrogen applied	39
90	"	Deep moderately well drained upland and bench soils with 41-60 pounds of nitrogen applied	39
91	"	Deep moderately well drained upland and bench soils with 61 pounds or more of nitrogen applied	39
92	"	Somewhat poorly drained upland and bench soils with 40 pounds or less of nitrogen applied	40
93	"	Somewhat poorly drained upland and bench soils with 41-60 pounds of nitrogen applied	40
94	"	Somewhat poorly drained upland and bench soils with 61 pounds or more of nitrogen applied	40
95	"	Deep moderately well drained bottom soils with 40 pounds or less of nitrogen applied	41
96	"	Deep moderately well drained bottom soils with 41-60 pounds of nitrogen applied	41
97	"	Deep moderately well drained bottom soils with 61 pounds or more of nitrogen applied	41
98	"	Low wet soils with 40 pounds or less of nitrogen applied	42
99	"	Low wet soils with 41-60 pounds of nitrogen applied	42
100	"	Low wet soils with 61 pounds or more of nitrogen applied.	42
101	"	All dry sloping hill soils	43
102	"	All deep moderately well drained upland and bench soils	43
103	"	Somewhat poorly drained upland and bench soils.	43
104	"	All deep moderately well drained bottom soils.	44
105	"	All low wet soils	44
106	Soybeans	All deep moderately well drained upland and bench soils	44
107	"	All somewhat poorly drained upland and bench soils.	45
108	"	All deep moderately well drained bottom soils.	45

APPENDIX B

Appendix Table 1. COTTON: Normal yield per acre and production practices, Adler silt loam, A+, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	669	669
Pounds of N	95.2	59	62
Pounds of P_2O_5	90.5	45	50
Pounds of K_2O	95.2	47	49
Other practices (times over):			
Flat breaking, spring	71.4	.71	1.00
Middle breaking, spring	66.7	1.33	2.00
Discing, spring	100.0	2.76	2.76
Listing, spring	9.5	.14	1.50
Harrowing	100.0	1.57	1.57
Pre-emerge	57.1	.57	1.00
Post-emerge	4.8	.05	1.00
Hoeing	100.0	2.76	2.76
Flame cultivation	9.5	.28	3.00
Cultivation	100.0	6.23	6.23
Insecticides	95.2	10.90	11.45
Defoliation	42.9	.43	1.00

[1] Based upon 21 observations. Farm drainage was indicated as 5 percent "poor", 29 percent "fair", and 66 percent "good". Rotation was indicated as 90 percent "all crops" and 10 percent "two-thirds crops"

Appendix Table 2. COTTON: Normal yield per acre and production practices, Atwood silt loam, C3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	606	606
Pounds of N	100.0	62	62
Pounds of P_2O_5	100.0	47	47
Pounds of K_2O	100.0	47	47
Other practices (times over):			
Flat breaking, fall	9.1	.09	1.00
Flat breaking, spring	75.8	.76	1.00
Middle breaking, spring	39.4	.67	1.69
Discing, spring	93.9	2.30	2.45
Listing, spring	27.3	.33	1.22
Harrowing	100.0	1.18	1.18
Pre-emerge	78.9	.79	1.00
Hoeing	100.0	2.00	2.00
Cultivation	100.0	5.33	5.33
Insecticides	97.0	9.21	9.50

[1] Based upon 33 observations. Farm drainage was indicated as 12 percent "poor", 61 percent "fair", and 27 percent "good". Rotation was indicated as 94 percent "all crops", 3 percent "one-half crops", and 3 percent "two-thirds crops".

Appendix Table 3. COTTON: Normal yield per acre and production practices, Bude silt loam, B1 and B2, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	486	486
Pounds of N	100.0	62	62
Pounds of P_2O_5	100.0	46	46
Pounds of K_2O	100.0	46	46
Other practices (times over):			
Flat breaking, fall	5.6	.06	1.00
Flat breaking, spring	50.0	.50	1.00
Middle breaking, spring	61.1	1.16	1.90
Discing, spring	100.0	2.27	2.27
Listing, spring	11.1	.11	1.00
Harrowing	94.4	1.33	1.41
Post-emerge	27.8	.28	1.00
Hoeing	100.0	2.00	2.00
Cultivation	100.0	6.00	6.00
Insecticides	94.4	7.55	8.00
Defoliation	11.1	.11	1.00

1/ Based upon 18 observations. Farm drainage was indicated as 12 percent "poor", 69 percent "fair", and 19 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 4. COTTON: Normal yield per acre and production practices, Calloway silt loam, B1 and B2, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	466	466
Pounds of N	100.0	52	52
Pounds of P_2O_5	100.0	44	44
Pounds of K_2O	100.0	47	47
Other practices (times over):			
Flat breaking, spring	50.0	.50	1.00
Middle breaking, spring	87.5	1.87	2.14
Discing, spring	100.0	2.00	2.00
Listing, spring	6.2	.06	1.00
Harrowing	100.0	1.56	1.56
Pre-emerge	31.2	.31	1.00
Hoeing	100.0	2.75	2.75
Cultivation	100.0	6.50	6.50
Insecticides	93.8	7.37	7.86
Defoliation	12.5	.13	1.00

1/ Based upon 16 observations. Farm drainage was indicated as 81 percent "fair" and 19 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 5. COTTON: Normal yield per acre and production practices, Collins silt loam, A+ and A1, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	650	650
Pounds of N	100.0	54	54
Pounds of P_2O_5	98.5	46	47
Pounds of K_2O	98.5	46	47
Other practices (times over):			
Flat breaking, spring	74.8	.75	1.00
Middle breaking, spring	68.7	1.26	1.84
Discing, spring	96.2	2.35	2.44
Listing, spring	12.2	.15	1.25
Harrowing	99.2	1.50	1.51
Pre-emerge	67.9	.68	1.00
Post-emerge	1.5	.02	1.00
Hoeing	100.0	2.40	2.40
Flame cultivation	3.1	.09	3.25
Cultivation	100.0	5.79	5.79
Insecticides	92.4	9.22	9.98
Defoliation	25.2	.25	1.00

1/ Based up 131 observations. Farm drainage was indicated as 10 percent "poor", 48 percent "fair", and 42 percent "good". Rotation was indicated as 96 percent "all crops" and 4 percent "two-thirds crops".

Appendix Table 6. COTTON: Normal yield per acre and production practices, Collins silt loam, 1.a. and A+, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	634	634
Pounds of N	98.7	58	58
Pounds of P_2O_5	97.5	47	48
Pounds of K_2O	97.5	47	48
Other practices (times over):			
Flat breaking, fall	1.3	.01	1.00
Flat breaking, spring	63.3	.63	1.00
Middle breaking, spring	78.5	1.49	1.90
Discing, spring	97.5	2.07	2.12
Listing, spring	13.9	.14	1.00
Harrowing	97.5	1.32	1.36
Pre-emerge	67.1	.67	1.00
Post-emerge	10.1	.11	1.12
Hoeing	100.0	2.43	2.43
Flame cultivation	3.8	.11	3.00
Cultivation	100.0	6.22	6.22
Insecticides	96.2	8.86	9.21
Defoliation	24.1	.24	1.00

1/ Based upon 79 observations. Farm drainage was indicated as 5 percent "poor", 53 percent "fair", and 42 percent "good". Rotation was indicated as 96 percent "all crops", 1 percent "one-half crops", and 3 percent "two-thirds crops".

Appendix Table 7. COTTON: Normal yield per acre and production practices, Collins silt loam, 1.a., B+, and B1, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	552	552
Pounds of N	100.0	47	47
Pounds of P_2O_5	100.0	40	40
Pounds of K_2O	100.0	40	40
Other practices (times over):			
Flat breaking, spring	46.2	.46	1.00
Middle breaking, spring	84.6	1.53	1.81
Discing, spring	92.3	2.07	2.25
Listing, spring	30.8	.38	1.25
Harrowing	100.0	1.23	1.23
Pre-emerge	61.5	.62	1.00
Hoeing	100.0	2.61	2.61
Cultivation	100.0	6.92	6.92
Insecticides	92.3	7.92	8.58
Defoliation	15.4	.15	1.00

1/ Based upon 13 observations. Farm drainage was indicated as 31 percent "poor", 8 percent "fair", and 61 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 8. COTTON: Normal yield per acre and production practices, Dulac silt loam, B3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	522	522
Pounds of N	100.0	48	48
Pounds of P_2O_5	100.0	48	48
Pounds of K_2O	100.0	48	48
Other practices (times over):			
Flat breaking, spring	71.4	.71	1.00
Middle breaking, fall	3.6	.04	1.00
Middle breaking, spring	35.7	.67	1.90
Discing, fall	3.6	.04	1.00
Discing, spring	92.8	2.53	2.73
Listing, spring	17.8	.21	1.20
Harrowing	100.0	1.60	1.60
Pre-emerge	64.3	.64	1.00
Hoeing	100.0	2.28	2.28
Cultivation	100.0	5.82	5.82
Insecticides	100.0	9.14	9.14
Defoliation	7.1	.07	1.00

1/ Based upon 28 observations. Farm drainage was indicated as 18 percent "poor", 71 percent "fair", and 11 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 9. COTTON: Normal yield per acre and production practices, Falaya silt loam, A+ and A1, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	615	615
Pounds of N	99.4	58	58
Pounds of P_2O_5	98.3	45	45
Pounds of K_2O	98.3	45	45
Other practices (times over):			
Flat breaking, fall	1.1	.01	1.00
Flat breaking, spring	56.3	.56	1.00
Middle breaking, fall	3.4	.03	1.00
Middle breaking, spring	67.2	1.16	1.72
Discing, fall	1.7	.03	2.00
Discing, spring	97.1	2.53	2.60
Listing, fall	1.1	.01	1.00
Listing, spring	32.8	.39	1.21
Harrowing	98.8	1.63	1.65
Pre-emerge	59.8	.60	1.00
Post-emerge	8.0	.15	1.92
Hoeing	100.0	2.32	2.32
Flame cultivation	4.6	.14	3.12
Cultivation	100.0	6.44	6.44
Insecticides	94.8	9.92	10.46
Defoliation	25.3	.25	1.02

[1] Based upon 174 observations. Farm drainage was indicated as 14 percent "poor", 58 percent "fair", and 28 percent "good". Rotation was indicated as 91 percent "all crops", 1 percent "one-half crops", and 8 percent "two-thirds crops".

Appendix Table 10. COTTON: Normal yield per acre and production practices, Falaya silt loam, 1.a. and A+, Mississippi Brown Loam Area, 1965. [1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	606	606
Pounds of N	100.0	58	58
Pounds of P_2O_5	97.0	46	47
Pounds of K_2O	97.0	46	47
Other practices (times over):			
Flat breaking, spring	54.3	.54	1.00
Middle breaking, spring	80.0	1.57	1.96
Discing, spring	91.4	2.02	2.21
Listing, spring	8.6	.09	1.00
Harrowing	100.0	1.68	1.68
Pre-emerge	54.3	.54	1.00
Post-emerge	2.8	.03	1.00
Hoeing	100.0	2.48	2.48
Flame cultivation	5.7	.17	3.00
Cultivation	100.0	6..51	6.51
Insecticides	97.1	10.14	10.44
Defoliation	28.6	.29	1.00

[1] Based upon 35 observations. Farm drainage was indicated as 9 percent "poor", 74 percent "fair", and 17 percent "good". Rotation was indicated as 97 percent "all crops" and 3 percent "two-thirds crops".

Appendix Table 11. COTTON: Normal yield per acre and production practices, Falaya silt loam, 1.a. and B+, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	637	637
Pounds of N	100.0	59	59
Pounds of P_2O_5	100.0	46	46
Pounds of K_2O	100.0	46	46
Other practices (times over):			
Flat breaking, fall	3.2	.03	1.00
Flat breaking, spring	80.6	.81	1.00
Middle breaking, spring	77.4	1.16	1.50
Discing, spring	100.0	2.67	2.67
Listing, spring	58.1	.61	1.05
Harrowing	100.0	1.58	1.58
Pre-emerge	74.2	.74	1.00
Post-emerge	6.5	.07	1.00
Hoeing	100.0	2.25	2.25
Cultivation	100.0	6.48	6.48
Insecticides	96.8	10.09	10.43
Defoliation	35.5	.36	1.00

1/ Based upon 31 observations. Farm drainage was indicated as 3 percent "poor", 42 percent "fair", and 55 percent "good". Rotation was indicated as 77 percent "all crops", 10 percent "one-half crops", and 13 percent "two-thirds crops".

Appendix Table 12. COTTON: Normal yield per acre and production practices, Falkner silt loam, B2, Mississipps Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	406	406
Pounds of N	96.6	45	46
Pounds of P_2O_5	96.6	42	44
Pounds of K_2O	96.6	41	43
Other practices (times over):			
Flat breaking, fall	3.4	.03	1.00
Flat breaking, spring	58.6	.59	1.00
Middle breaking, fall	3.4	.03	1.00
Middle breaking, spring	31.0	.58	1.88
Discing, fall	3.4	.03	1.00
Discing, spring	96.6	2.65	2.75
Listing, spring	34.5	.37	1.10
Harrowing	96.6	1.68	1.75
Pre-emerge	58.6	.58	1.00
Hoeing	100.0	2.30	2.30
Cultivation	100.0	6.00	6.00
Insecticides	96.6	8.17	8.46

1/ Based upon 29 observations. Farm drainage was indicated as 7 percent "poor", 90 percent "fair", and 3 percent "good". Rotation was indicated as 79 percent "all crops", 4 percent "one-half crops", and 17 percent "two-thirds crops".

Appendix Table 13. COTTON: Normal yield per acre and production practices, Grenada silt loam, A1, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	606	606
Pounds of N	100.0	74	74
Pounds of P_2O_5	92.9	54	58
Pounds of K_2O	92.9	54	58
Other practices (times over):			
Flat breaking, spring	78.6	.79	1.00
Middle breaking, spring	78.8	1.35	1.72
Discing, fall	7.1	.14	2.00
Discing, spring	100.0	2.28	2.28
Harrowing	100.0	1.85	1.85
Pre-emerge	57.1	.57	1.00
Post-emerge	21.4	.35	1.66
Hoeing	100.0	2.64	2.64
Flame cultivation	21.4	.57	2.66
Cultivation	100.0	6.14	6.14
Insecticides	100.0	10.71	10.71
Defoliation	50.0	.50	1.00

1/ Based upon 14 observations. Farm drainage was indicated as 36 percent "fair" and 64 percent "good". Rotation was indicated as 93 percent "all crops" and 7 percent "two-thirds crops".

Appendix Table 14. COTTON: Normal yield per acre and production practices, Grenada silt loam, B2, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	501	501
Pounds of N	100.0	57	57
Pounds of P_2O_5	100.0	47	47
Pounds of K_2O	100.0	47	47
Other practices (times over):			
Flat breaking, fall	2.3	.02	1.00
Flat breaking, spring	58.0	.59	1.01
Middle breaking, fall	1.1	.02	2.00
Middle breaking, spring	83.0	1.71	2.06
Discing, spring	78.4	1.62	2.07
Listing, spring	9.1	.10	1.12
Harrowing	100.0	1.61	1.61
Pre-emerge	51.1	.51	1.00
Post-emerge	2.3	.02	1.00
Hoeing	100.0	2.27	2.27
Flame cultivation	4.5	.22	5.00
Cultivation	100.0	5.87	5.87
Insecticides	90.9	7.28	8.01
Defoliation	6.8	.07	1.00

1/ Based upon 88 observations. Farm drainage was indicated as 6 percent "poor", 67 percent "fair", and 27 percent "good". Rotation was indicated as 94 percent "all crops", 4 percent "one-half crops", and 2 percent "two-thirds crops".

Appendix Table 15. COTTON: Normal yield per acre and production practices, Grenada silt loam, B3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	418	418
Pounds of N	98.6	46	47
Pounds of P_2O_5	97.3	38	39
Pounds of K_2O	97.3	37	38
Other practices (times over):			
Flat breaking, fall	2.7	.02	1.00
Flat breaking, spring	39.2	.39	1.00
Middle breaking, spring	89.2	1.87	2.10
Discing, spring	78.4	1.58	2.01
Listing, spring	13.5	.21	1.60
Harrowing	95.9	1.44	1.50
Pre-emerge	27.0	.27	1.00
Post-emerge	1.4	.01	1.00
Hoeing	100.0	2.23	2.23
Cultivation	100.0	5.94	5.94
Insecticides	89.2	6.09	6.83
Defoliation	5.4	.05	1.00

1/ Based upon 74 observations. Farm drainage was indicated as 7 percent "poor", 78 percent "fair", and 15 percent "good". Rotation was indicated as 96 percent "all crops" and 4 percent "two-thirds crops".

Appendix Table 16. COTTON: Normal yield per acre and production practices, Grenada silt loam, C3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	377	377
Pounds of N	100.0	41	41
Pounds of P_2O_5	100.0	36	36
Pounds of K_2O	100.0	34	34
Other practices (times over):			
Flat breaking, spring	40.0	.40	1.00
Middle breaking, spring	93.3	1.86	2.00
Discing, spring	86.7	1.73	2.00
Listing, spring	16.7	.20	1.20
Harrowing	100.0	1.53	1.53
Pre-emerge	30.0	.30	1.00
Post-emerge	3.3	.03	1.00
Hoeing	96.7	2.30	2.37
Cultivation	100.0	6.33	6.33
Insecticides	90.0	6.00	6.67
Defoliation	10.0	.10	1.00

1/ Based upon 30 observations. Farm drainage was indicated as 7 percent "poor", 73 percent "fair", and 20 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 17. COTTON: Normal yield per acre and production practices, Hatchie silt loam, Al, Mississippi Brown Loam Area, 1965. 1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	544	544
Pounds of N	100.0	44	44
Pounds of P_2O_5	100.0	46	46
Pounds of K_2O	100.0	46	46
Other practices (times over):			
Flat breaking, spring	63.0	.63	1.00
Middle breaking, spring	74.1	1.18	1.60
Discing, spring	100.0	2.66	2.66
Listing, spring	81.5	1.03	1.27
Harrowing	100.0	1.92	1.92
Pre-emerge	66.7	.67	1.00
Hoeing	100.0	2.18	2.18
Flame cultivation	11.1	.29	2.66
Cultivation	100.0	7.25	7.25
Insecticides	96.3	10.07	10.46
Defoliation	22.2	.22	1.00

1/ Based upon 27 observations. Farm drainage was indicated as 40 percent "fair" and 60 percent "good". Rotation was indicated as 62 percent "all crops" and 38 percent "two-thirds crops".

Appendix Table 18. COTTON: Normal yield per acre and production practices, Loring silt loam, B2, Mississippi Brown Loam Area, 1965. 1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	481	481
Pounds of N	100.0	40	40
Pounds of P_2O_5	98.0	41	42
Pounds of K_2O	98.0	41	42
Other practices (times over):			
Flat breaking, fall	2.0	.02	1.00
Flat breaking, spring	58.0	.58	1.00
Middle breaking, fall	2.0	.02	1.00
Middle breaking, spring	92.0	1.84	2.00
Discing, spring	86.0	1.72	2.00
Listing, spring	2.0	.02	1.00
Harrowing	100.0	1.62	1.62
Pre-emerge	32.0	.32	1.00
Hoeing	100.0	2.54	2.54
Cultivation	100.0	5.40	5.40
Insecticides	70.0	4.62	6.60
Defolation	2.0	.02	1.00

1/ Based upon 50 observations. Farm drainage was indicated as 2 percent "poor", 82 percent "fair", and 16 percent "good". Rotation was indicated as 94 percent "all crops", 2 percent "one-fourth crops", 2 percent "one-half crops", and 2 percent "two-thirds crops".

Appendix Table 19. COTTON: Normal yield per acre and production practices, Loring silt loam, B3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	496	496
Pounds of N	100.0	56	56
Pounds of P_2O_5	100.0	42	42
Pounds of K_2O	100.0	42	42
Other practices (times over):			
Flat breaking, spring	50.0	.50	1.00
Middle breaking, fall	4.2	.04	1.00
Middle breaking, spring	91.7	1.91	2.09
Discing, spring	79.2	1.58	2.00
Listing, spring	12.5	.13	1.00
Harrowing	100.0	1.58	1.58
Pre-emerge	50.0	.50	1.00
Post-emerge	4.2	.04	1.00
Hoeing	95.8	2.25	2.34
Flame cultivation	4.2	.12	3.00
Cultivation	100.0	6.04	6.04
Insecticides	95.8	7.91	8.26
Defoliation	4.2	.04	1.00

[1] Based upon 24 observations. Farm drainage was indicated as 8 percent "poor", 75 percent "fair", and 17 percent "good". Rotation was indicated as 91 percent "all crops" and 9 percent "two-thirds crops".

Appendix Table 20. COTTON: Normal yield per acre and production practices, Loring silt loam, C3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	462	462
Pounds of N	100.0	45	45
Pounds of P_2O_5	100.0	42	42
Pounds of K_2O	100.0	42	42
Other practices (times over):			
Flat breaking, spring	17.1	.17	1.00
Middle breaking, fall	2.9	.03	1.00
Middle breaking, spring	94.3	1.88	2.00
Discing, spring	91.4	1.97	2.15
Listing, spring	2.9	.03	1.00
Harrowing	97.1	1.28	1.32
Pre-emerge	45.7	.46	1.00
Hoeing	100.0	2.48	2.48
Flame cultivation	2.9	.08	3.00
Cultivation	100.0	6.68	6.68
Insecticides	97.1	8.42	8.67
Defoliation	2.9	.03	1.00

[1] Based upon 35 observations. Farm drainage was indicated as 11 percent "poor", 63 percent "fair", and 26 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 21. COTTON: Normal yield per acre and production practices, Loring silty clay loam, C3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	488	488
Pounds of N	100.0	47	47
Pounds of P_2O_5	94.7	43	45
Pounds of K_2O	94.7	43	45
Other practices (times over):			
Flat breaking, spring	84.2	.84	1.00
Middle breaking, spring	73.7	1.36	1.85
Discing, spring	84.2	1.78	2.12
Harrowing	100.0	1.73	1.73
Pre-emerge	47.4	.47	1.00
Hoeing	100.0	2.47	2.47
Cultivation	100.0	5.26	5.26
Insecticides	78.9	5.63	7.13

[1] Based upon 19 observations. Farm drainage was indicated as 11 percent "poor" and 89 percent "fair". Rotation was indicated as 100 percent "all crops".

Appendix Table 22. COTTON: Normal yield per acre and production practices, Memphis silt loam, A1, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	649	649
Pounds of N	100.0	70	70
Pounds of P_2O_5	94.3	44	47
Pounds of K_2O	94.3	44	47
Other practices (time over):			
Flat breaking, spring	68.6	.69	1.00
Middle breaking, fall	5.7	.06	1.00
Middle breaking, spring	68.6	1.25	1.83
Discing, fall	5.7	.06	1.00
Discing, spring	100.0	2.65	2.65
Listing, spring	11.4	.11	1.00
Harrowing	97.1	1.48	1.52
Pre-emerge	37.1	.37	1.00
Hoeing	100.0	2.65	2.65
Flame cultivation	2.9	.05	2.00
Cultivation	100.0	6.70	6.70
Insecticides	100.0	11.54	11.54
Defoliation	37.1	.37	1.00

1/ Based upon 35 observations. Farm drainage was indicated as 20 percent "fair" and 80 percent "good". Rotation was indicated as 91 percent "all crops", 3 percent "one-half crops", and 6 percent "two-thirds".

Appendix Table 23. COTTON: Normal yield per acre and production practices, Memphis silt loam, B1 and B2, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	510	510
Pounds of N	100.0	54	54
Pounds of P_2O_5	94.4	42	44
Pounds of K_2O	94.4	41	43
Other practices (times over):			
Flat breaking, spring	75.0	.75	1.00
Middle breaking, spring	83.3	1.58	1.90
Discing, spring	94.4	2.27	2.41
Listing, spring	2.8	.03	1.00
Harrowing	97.2	1.52	1.57
Pre-emerge	44.4	.44	1.00
Hoeing	100.0	2.50	2.50
Cultivation	100.0	5.88	5.88
Insecticides	94.4	7.61	8.05
Defoliation	2.8	.03	1.00

1/ Based upon 36 observations. Farm drainage was indicated as 5 percent "poor", 64 percent "fair", and 31 percent "good". Rotatation was indicated as 94 percent "all crops", 3 percent "one-fourth crops", and 3 percent "one-half crops".

Appendix Table 24. COTTON: Normal yield per acre and production practices, Memphis silt loam, B3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	449	449
Pounds of N	100.0	45	45
Pounds of P_2O_5	95.7	36	38
Pounds of K_2O	95.7	33	35
Other practices (times over):			
Flat breaking, spring	32.6	.33	1.00
Middle breaking, fall	4.3	.04	1.00
Middle breaking, spring	97.8	1.91	1.95
Discing, spring	97.8	2.43	2.48
Listing, spring	2.2	.02	1.00
Harrowing	100.0	1.65	1.65
Pre-emerge	2.2	.02	1.00
Hoeing	100.0	2.73	2.73
Cultivation	100.0	5.89	5.89
Insecticides	93.5	7.52	8.04
Defoliation	2.2	.02	1.00

1/ Based upon 46 observations. Farm drainage was indicated as 7 percent "poor", 80 percent "fair", and 13 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 25. COTTON: Normal yield per acre and production practices, Memphis silt loam, C3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	409	409
Pounds of N	100.0	45	45
Pounds of P_2O_5	95.5	39	41
Pounds of K_2O	95.5	38	39
Other practices (times over):			
Flat breaking, spring	45.5	.46	1.00
Middle breaking, spring	81.8	1.63	2.00
Discing, spring	100.0	2.45	2.45
Harrowing	100.0	1.63	1.63
Hoeing	100.0	2.63	2.63
Cultivation	100.0	5.72	5.72
Insecticides	100.0	6.68	6.68

1/ Based upon 22 observations. Farm drainage was indicated as 32 percent "poor", 50 percent "fair", and 18 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 26. COTTON: Normal yield per acre and production practices, Memphis and Loring silt loam, B2 and B3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	462	462
Pounds of N	100.0	45	45
Pounds of P_2O_5	88.9	34	39
Pounds of K_2O	88.9	32	36
Other practices (times over):			
Flat breaking, spring	33.3	.33	1.00
Middle breaking, spring	100.0	2.00	2.00
Discing, fall	5.6	.06	1.00
Discing, spring	100.0	2.67	2.67
Listing, spring	5.6	.06	1.00
Harrowing	100.0	1.38	1.38
Hoeing	100.0	2.83	2.83
Cultivation	100.0	5.94	5.94
Insecticides	100.0	7.22	7.22

1/ Based upon 18 observations. Farm drainage was indicated as 11 percent "poor", 83 percent "fair", and 6 percent "good". Rotation was indicated as 94 percent "all crops" and 6 percent "one-fourth crops".

Appendix Table 27. COTTON: Normal yield per acre and production practices, Olivier silt loam, A+ and A1, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	418	418
Pounds of N	100.0	43	43
Pounds of P_2O_5	100.0	35	35
Pounds of K_2O	100.0	35	35
Other practices (times over):			
Flat breaking, spring	28.6	.29	1.00
Middle breaking, spring	85.7	1.92	2.25
Discing, spring	85.7	1.50	1.75
Listing, spring	7.1	.07	1.00
Harrowing	92.9	1.78	1.92
Pre-emerge	28.6	.29	1.00
Post-emerge	7.1	.07	1.00
Hoeing	100.0	2.28	2.28
Cultivation	100.0	5.92	5.92
Insecticides	92.9	6.57	7.07

1/ Based upon 14 observations. Farm drainage was indicated as 22 percent "poor", 64 percent "fair", and 14 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 28. COTTON: Normal yield per acre and production practices, Olivier silt loam B1 and B2, Mississippi Brown Loam Area, 1965. 1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	451	451
Pounds of N	100.0	59	59
Pounds of P_2O_5	100.0	48	48
Pounds of K_2O	100.0	44	44
Other practices (times over):			
Flat breaking, spring	50.0	.50	1.00
Middle breaking, spring	80.0	1.60	2.00
Discing, spring	90.0	1.90	2.11
Listing, spring	20.0	.30	1.50
Harrowing	100.0	1.50	1.50
Pre-emerge	40.0	.40	1.00
Hoeing	100.0	2.20	2.20
Cultivation	100.0	5.80	5.80
Insecticides	90.0	6.50	7.22

1/ Based upon 10 observations. Farm drainage was indicated as 20 percent "poor", 60 percent "fair", and 20 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 29. COTTON: Normal yield per acre and production practices, Providence silt loam, B2, Mississippi Brown Loam Area, 1965. 1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	562	562
Pounds of N	100.0	64	64
Pounds of P_2O_5	100.0	48	48
Pounds of K_2O	100.0	52	52
Other practices (times over):			
Flat breaking, spring	55.2	.55	1.00
Middle breaking, spring	62.1	1.24	2.00
Discing, spring	93.1	2.24	2.40
Listing, spring	10.3	.10	1.00
Harrowing	100.0	1.34	1.34
Pre-emerge	27.6	.28	1.00
Hoeing	100.0	2.37	2.37
Cultivation	100.0	5.82	5.82
Insecticides	96.6	8.68	9.00
Defoliation	10.3	.10	1.00

1/ Based upon 29 observations. Farm drainage was indicated as 71 percent "fair" and 29 percent "good". Rotation was indicated as 90 percent "all crops", 3 percent "one-fourth crops", and 7 percent "two-thirds crops".

Appendix Table 30. COTTON: Normal yield per acre and production practices, Providence silt loam, B3, Mississippi Brown Loam Area, 1965. 1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	547	547
Pounds of N	100.0	56	56
Pounds of P_2O_5	100.0	48	48
Pounds of K_2O	100.0	48	48
Other practices (times over):			
Flat breaking, spring	70.6	.71	1.00
Middle breaking, spring	47.1	.94	2.00
Discing, spring	94.1	2.29	2.43
Harrowing	100.0	1.17	1.17
Pre-emerge	58.8	.59	1.00
Hoeing	100.0	2.29	2.29
Cultivation	100.0	5.41	5.41
Insecticides	100.0	9.29	9.29

1/ Based upon 17 observations. Farm drainage was indicated as 18 percent "poor", 59 percent "fair", and 23 percent "good". Rotation was indicated as 88 percent "all crops" and 12 percent "two-thirds crops".

Appendix Table 31. COTTON: Normal yield per acre and production practices, Providence silt loam, C3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	494	494
Pounds of N	100.0	49	49
Pounds of P_2O_5	100.0	46	46
Pounds of K_2O	100.0	47	47
Other practices (times over):			
Flat breaking, fall	3.7	.04	1.00
Flat breaking, spring	77.8	.78	1.00
Middle breaking, spring	33.3	.66	2.00
Discing, spring	96.3	2.29	2.38
Listing, spring	3.7	.07	2.00
Harrowing	100.0	1.44	1.44
Pre-emerge	40.7	.41	1.00
Hoeing	100.0	2.52	2.52
Cultivation	100.0	5.48	5.48
Insecticides	96.3	8.11	8.42
Defoliation	3.7	.04	1.00

[1] Based upon 27 observations. Farm drainage was indicated as 4 percent "poor", 74 percent "fair", and 22 percent "good". Rotation was indicated as 92 percent "all crops", 4 percent "one-half crops", and 4 percent "two-thirds crops".

Appendix Table 32. COTTON: Normal yield per acre and production practices, Richland silt loam, A1 and A2, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	523	523
Pounds of N	100.0	65	65
Pounds of P_2O_5	93.3	36	38
Pounds of K_2O	93.3	35	37
Other practices (times over):			
Flat breaking, spring	60.0	.60	1.00
Middle breaking, fall	86.7	1.67	1.92
Discing, spring	80.0	1.67	2.08
Listing, spring	13.3	.20	1.50
Harrowing	93.3	1.26	1.35
Pre-emerge	40.0	.40	1.00
Post-emerge	6.7	.13	2.00
Hoeing	100.0	1.80	1.80
Cultivation	100.0	6.00	6.00
Insecticides	80.0	7.53	9.41
Defoliation	6.7	.07	1.00

[1] Based upon 15 observations. Farm drainage was indicated as 87 percent "fair" and 13 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 33. COTTON: Normal yield per acre and production practices, Richland silt loam, B2, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	488	488
Pounds of N	100.0	43	43
Pounds of P_2O_5	100.0	43	43
Pounds of K_2O	100.0	43	43
Other practices (times over):			
Flat breaking, spring	53.8	.54	1.00
Middle breaking, spring	92.3	2.00	2.16
Discing, spring	84.6	1.61	1.90
Listing, spring	7.7	.15	2.00
Harrowing	100.0	1.61	1.61
Pre-emerge	46.2	.46	1.00
Hoeing	100.0	2.15	2.15
Cultivation	100.0	5.76	5.76
Insecticides	92.3	7.46	8.08
Defoliation	7.7	.08	1.00

[1] Based upon 13 observations. Farm drainage was indicated as 69 percent "fair" and 31 percent "good" Rotation was indicated as 100 percent "all crops".

Appendix Table 34. COTTON: Normal yield per acre and production practices, all dry sloping hill soils, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	476	476
Pounds of N	100.0	49	49
Pounds of P_2O_5	98.8	42	43
Pounds of K_2O	98.8	42	43
Other practices (times over):			
Flat breaking, fall	2.4	.02	1.00
Flat breaking, spring	54.2	.54	1.00
Middle breaking, spring	69.3	1.34	1.94
Discing, spring	92.2	2.09	2.26
Listing, spring	9.6	.12	1.25
Harrowing	99.4	1.43	1.44
Pre-emerge	42.8	.43	1.00
Hoeing	100.0	2.36	2.36
Flame cultivation	.6	.01	3.00
Cultivation	100.0	5.86	5.86
Insecticides	94.0	7.54	8.02
Defoliation	3.0	.03	1.00

[1] Based upon 166 observations. Farm drainage was indicated as 11 percent "poor", 69 percent "fair", and 20 percent "good". Rotation was indicated as 98 percent "all crops", 1 percent "one-half crops", and 1 percent "two-thirds crops".

Appendix Table 35. COTTON: Normal yield per acre and production practices, all deep moderately well drained upland and bench soils, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	503	503
Pounds of N	99.8	53	53
Pounds of P_2O_5	97.4	43	44
Pounds of K_2O	97.4	43	44
Other practices (times over):			
Flat breaking, fall	1.0	.01	1.00
Flat breaking, spring	55.6	.56	1.00
Middle breaking, fall	1.6	.02	1.12
Middle breaking, spring	80.5	1.61	2.00
Discing, fall	1.0	.01	1.20
Discing, spring	87.8	2.00	2.27
Listing, spring	8.3	.10	1.24
Harrowing	98.8	1.52	1.54
Pre-emerge	37.1	.37	1.00
Post-emerge	1.6	.02	1.37
Hoeing	100.0	2.39	2.39
Flame cultivation	1.8	.06	3.66
Cultivation	100.0	5.88	5.88
Insecticides	91.3	7.61	8.34
Defoliation	8.3	.09	1.12

[1] Based upon 493 observations. Farm drainage was indicated as 6 percent "poor", 68 percent "fair", and 26 percent "good". Rotation was indicated as 95 percent "all crops", 1 percent "one-fourth crops", 1 percent "one-half crops", and 3 percent "two-thirds crops".

Appendix Table 36. COTTON: Normal yield per acre and production practices, all somewhat poorly drained upland and bench soils, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	468	468
Pounds of N	99.2	50	51
Pounds of P_2O_5	99.2	44	45
Pounds of K_2O	99.2	44	45
Other practices (times over):			
Flat breaking, fall	1.6	.02	1.00
Flat breaking, spring	56.7	.57	1.00
Middle breaking, spring	63.8	1.22	1.92
Discing, fall	1.6	.02	1.00
Discing, spring	96.9	2.33	2.40
Listing, spring	32.3	.38	1.19
Harrowing	97.6	1.65	1.69
Pre-emerge	46.5	.47	1.00
Hoeing	100.0	2.29	2.29
Flame cultivation	2.4	.06	2.66
Cultivation	100.0	6.30	6.30
Insecticides	95.3	8.12	8.12
Defoliation	10.2	.10	1.00

[1] Based upon 127 observations. Farm drainage was indicated as 10 percent "poor", 66 percent "fair", and 24 percent "good". Rotation was indicated as 88 percent "all crops", 1 percent "one-half crops", and 11 percent "two-thirds crops".

Appendix Table 37. COTTON: Normal yield per acre and production practices, all deep moderately well drained bottom soils, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	629	629
Pounds of N	99.4	57	57
Pounds of P_2O_5	98.0	46	47
Pounds of K_2O	98.2	46	47
Other practices (times over):			
Flat breaking, spring	64.3	.64	1.00
Middle breaking, fall	1.4	.01	1.00
Middle breaking, spring	71.2	1.28	1.80
Discing, fall	.8	.01	1.75
Discing, spring	96.7	2.38	2.47
Listing, spring	22.9	.26	1.16
Harrowing	99.0	1.53	1.54
Pre-emerge	63.7	.64	1.00
Post-emerge	5.9	.08	1.48
Hoeing	100.0	2.39	2.39
Flame cultivation	4.0	.12	3.00
Cultivation	100.0	6.25	6.25
Insecticides	94.7	9.59	10.13
Defoliation	26.9	.27	1.00

[1] Based upon 490 observations. Farm drainage was indicated as 10 percent "poor", 52 percent "fair", and 38 percent "good". Rotation was indicated as 93 percent "all crops", 1 percent "one-half crops", and 6 percent "two-thirds crops".

Appendix Table 38. COTTON: Normal yield per acre and production practices, all low wet soils, Mississippi Brown Loam area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	513	513
Pounds of N	100.0	46	46
Pounds of P_2O_5	100.0	46	46
Pounds of K_2O	100.0	46	46
Other practices (times over):			
Flat breaking, spring	47.8	.48	1.00
Middle breaking, spring	69.6	1.21	1.75
Discing, spring	95.7	2.52	2.63
Listing, spring	34.8	.35	1.00
Harrowing	100.0	1.91	1.91
Pre-emerge	78.3	.78	1.00
Hoeing	100.0	2.30	2.30
Flame cultivation	4.3	.08	2.00
Cultivation	100.0	6.69	6.69
Insecticides	100.0	10.08	10.08
Defoliation	30.4	.30	1.00

1/ Based upon 23 observations. Farm drainage was indicated as 4 percent "poor", 65 percent "fair", and 31 percent "good". Rotation was indicated as 82 percent "all crops", 4 percent "one-half crops", and 14 percent "two-thirds crops".

Appendix Table 39. COTTON: Normal yield per acre and production practices, dry sloping hill soils with 40 pounds or less of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	385	385
Pounds of N	100.0	32	32
Pounds of P_2O_5	97.3	35	36
Pounds of K_2O	97.3	34	35
Other practices (times over):			
Flat breaking, spring	38.7	.39	1.00
Middle breaking, fall	1.3	.01	1.00
Middle breaking, spring	82.7	1.70	2.06
Discing, spring	86.7	1.78	2.06
Listing, spring	4.0	.05	1.33
Harrowing	98.7	1.56	1.58
Pre-emerge	21.3	.21	1.00
Hoeing	100.0	2.41	2.41
Cultivation	100.0	5.81	5.81
Insecticides	90.7	5.72	6.30

1/ Based upon 75 observations. Farm drainage was indicated as 17 percent "poor", 63 percent "fair", and 20 percent "good". Rotation was indicated as 98 percent "all crops", 1 percent "one-half crops", and 1 percent "two-thirds crops"

Appendix Table 40. COTTON: Normal yield per acre and production practices, dry sloping hill soils with 41-60 pounds of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs lint)	100.0	501	501
Pounds of N	100.0	52	52
Pounds of P_2O_5	100.0	47	47
Pounds of K_2O	100.0	47	47
Other practices (times over):			
Flat breaking, fall	2.0	.02	1.00
Flat breaking, spring	66.7	.67	1.00
Middle breaking, spring	62.7	1.17	1.87
Discing, spring	94.1	2.17	2.31
Listing, spring	11.8	.15	1.33
Harrowing	100.0	1.43	1.43
Pre-emerge	51.0	.51	1.00
Hoeing	100.0	2.48	2.48
Cultivation	100.0	5.90	5.90
Insecticides	96.1	8.25	8.59
Defoliation	3.9	.04	1.00

1/ Based upon 51 observations. Farm drainage was indicated as 10 percent "poor", 72 percent "fair", and 18 percent "good". Rotation was indicated as 98 percent "all crops" and 2 percent "one-half crops".

Appendix Table 41. COTTON: Normal yield per acre and production practices, dry sloping hill soils with 61 pounds or more of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	615	615
Pounds of N	100.0	75	75
Pounds of P_2O_5	100.0	50	50
Pounds of K_2O	100.0	50	50
Other practices (times over):			
Flat breaking, fall	7.5	.08	1.00
Flat breaking, spring	67.5	.68	1.00
Middle breaking, spring	52.5	.90	1.71
Discing, spring	100.0	2.55	2.55
Listing, spring	17.5	.20	1.14
Harrowing	100.0	1.20	1.20
Pre-emerge	72.5	.72	1.00
Post-emerge	2.5	.02	1.00
Hoeing	100.0	2.20	2.20
Flame cultivation	2.5	.08	3.00
Cultivation	100.0	5.92	5.92
Insecticides	97.5	10.05	10.30
Defoliation	7.5	.08	1.00

[1] Based upon 40 observations. Farm drainage was indicated as 5 percent "poor", 70 percent "fair", and 25 percent "good". Rotation was indicated as 98 percent "all crops" and 2 percent "two-thirds crops".

Appendix Table 42. COTTON: Normal yield per acre and production practices, deep moderately well drained upland and bench soils with 40 pounds or less of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	415	415
Pounds of N	99.5	31	31
Pounds of P_2O_5	96.3	33	35
Pounds of K_2O	96.3	33	35
Other practices (times over):			
Flat breaking, fall	2.1	.02	1.00
Flat breaking, spring	40.1	.40	1.00
Middle breaking, fall	1.6	.02	1.00
Middle breaking, spring	89.3	1.83	2.05
Discing, spring	81.3	1.71	2.10
Listing, spring	10.7	.14	1.40
Harrowing	98.4	1.60	1.63
Pre-emerge	12.8	.13	1.00
Hoeing	100.0	2.44	2.44
Cultivation	100.0	5.70	5.70
Insecticides	79.1	4.87	6.15
Defoliation	1.1	.01	1.00

[1] Based upon 187 observations. Farm drainage was indicated as 7 percent "poor", 77 percent "fair", and 16 percent "good". Rotation was indicated as 95 percent "all crops", 1 percent "one-fourth crops", 2 percent "one-half crops", and 2 percent "two-thirds crops".

Appendix Table 43. COTTON: Normal yield per acre and production practices, deep moderately well drained upland and bench soils with 41-60 pounds of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	507	507
Pounds of N	100.0	52	52
Pounds of P_2O_5	99.3	45	45
Pounds of K_2O	99.3	45	45
Other practices (times over):			
Flat breaking, spring	56.8	.57	1.00
Middle breaking, fall	2.1	.02	1.00
Middle breaking, spring	75.3	1.50	2.00
Discing, spring	92.5	2.19	2.37
Listing, spring	6.8	.08	1.20
Harrowing	98.6	1.51	1.53
Pre-emerge	43.2	.43	1.00
Hoeing	100.0	2.47	2.47
Cultivation	100.0	5.81	5.81
Insecticides	98.6	8.29	8.40
Defoliation	2.7	.03	1.00

[1] Based upon 146 observations. Farm drainage was indicated as 8 percent "poor", 71 percent "fair", and 21 percent "good". Rotation was indicated as 98 percent "all crops", 1 percent "one-fourth crops", and 1 percent "two-thirds crops".

Appendix Table 44. COTTON: Normal yield per acre and production practices, deep moderately well drained upland and bench soils with 61 pounds or more of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	602	602
Pounds of N	100.0	80	80
Pounds of P_2O_5	96.9	51	53
Pounds of K_2O	96.9	51	53
Other practices (times over):			
Flat breaking, spring	72.5	.73	1.00
Middle breaking, fall	1.3	.01	1.00
Middle breaking, spring	75.0	1.45	1.94
Discing, fall	2.5	.03	1.25
Discing, spring	91.3	2.16	2.37
Listing, spring	6.9	.07	1.00
Harrowing	99.4	1.44	1.45
Pre-emerge	60.0	.60	1.00
Post-emerge	5.0	.06	1.37
Hoeing	100.0	2.27	2.27
Flame cultivation	5.6	.20	3.66
Cultivation	100.0	6.15	6.15
Insecticides	98.8	10.20	10.32
Defoliation	21.9	.25	1.14

1/ Based upon 160 observations. Farm drainage was indicated as 3 percent "poor", 56 percent "fair", and 41 percent "good". Rotation was indicated as 90 percent "all crops", 1 percent "one-fourth crops", 2 percent "one-half crops", and 7 percent "two-thirds crops".

Appendix Table 45. COTTON. Normal yield per acre and production practices, somewhat poorly drained upland and bench soils with 40 pounds or less of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	406	406
Pounds of N	98.0	31	32
Pounds of P_2O_5	98.0	37	38
Pounds of K_2O	98.0	36	37
Other practices (times over):			
Flat breaking, fall	2.0	.02	1.00
Flat breaking, spring	56.9	.57	1.00
Middle breaking, spring	64.7	1.25	1.93
Discing, spring	92.2	2.15	2.34
Listing, spring	35.3	.43	1.22
Harrowing	98.0	1.74	1.78
Pre-emerge	35.3	.35	1.00
Post-emerge	2.0	.02	1.00
Hoeing	100.0	2.35	2.35
Flame cultivation	2.0	.06	3.00
Cultivation	100.0	6.18	6.18
Insecticides	88.2	6.19	7.02
Defoliation	3.9	.04	1.00

1/ Based upon 51 observations. Farm drainage was indicated as 10 percent "poor", 70 percent "fair", and 20 percent "good". Rotation was indicated as 92 percent "all crops" and 8 percent "two-thirds crops".

Appendix Table 46. COTTON: Normal yield per acre and production practices, somewhat poorly drained upland and bench soils with 41-60 pounds of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	487	487
Pounds of N	100.0	54	54
Pounds of P_2O_5	100.0	48	48
Pounds of K_2O	100.0	48	48
Other practices (times over):			
Flat breaking, spring	49.0	.49	1.00
Middle breaking, fall	2.0	.02	1.00
Middle breaking, spring	63.3	1.26	2.00
Discing, fall	2.0	.02	1.00
Discing, spring	100.0	2.42	2.42
Listing, spring	28.6	.34	1.21
Harrowing	98.0	1.53	1.56
Pre-emerge	38.8	.39	1.00
Hoeing	100.0	2.34	2.34
Cultivation	100.0	6.44	6.44
Insecticides	100.0	8.53	8.53
Defoliation	4.1	.04	1.00

1/ Based upon 49 observations. Farm drainage was indicated as 8 percent "poor, 62 percent "fair", and 30 percent "good". Rotation was indicated as 86 percent "all crops", 2 percent "one-half crops", and 12 percent "two-thirds crops."

Appendix Table 47. COTTON: Normal yield per acre and production practices, somewhat poorly drained upland and bench soils with 61 pounds or more of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	550	550
Pounds of N	100.0	81	81
Pounds of P_2O_5	100.0	51	51
Pounds of K_2O	100.0	51	51
Other practices (times over):			
Flat breaking, fall	3.7	.04	1.00
Flat breaking, spring	70.4	.70	1.00
Middle breaking, spring	63.0	1.11	1.76
Discing, fall	3.7	.04	1.00
Discing, spring	100.0	2.48	2.48
Listing, spring	33.3	.37	1.11
Harrowing	96.3	1.70	1.76
Pre-emerge	81.5	.82	1.00
Hoeing	100.0	2.14	2.14
Flame cultivation	7.4	.18	2.50
Cultivation	100.0	6.29	6.29
Insecticides	100.0	11.03	11.03
Defoliation	33.3	.33	1.00

1/ Based upon 27 observations. Farm drainage was indicated as 11 percent "poor", 67 percent "fair", and 22 percent "good". Rotation was indicated as 85 percent "all crops" and 15 percent "two-thirds crops".

Appendix Table 48. COTTON: Normal yield per acre and production practices, deep moderately well drained bottom soils with 40 pounds or less of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	557	557
Pounds of N	98.0	30	31
Pounds of P_2O_5	95.4	37	39
Pounds of K_2O	95.4	37	39
Other practices (times over):			
Flat breaking, spring	55.3	.55	1.00
Middle breaking, spring	75.0	1.36	1.82
Discing, fall	.6	.02	4.00
Discing, spring	92.8	2.13	2.29
Listing, spring	24.3	.28	1.16
Harrowing	99.3	1.57	1.58
Pre-emerge	42.8	.43	1.00
Post-emerge	2.0	.03	1.67
Hoeing	100.0	2.49	2.49
Flame cultivation	.7	.02	3.00
Cultivation	100.0	5.96	5.96
Insecticides	88.8	7.29	8.21
Defoliation	5.9	.06	1.00

1/ Based upon 152 observations. Farm drainage was indicated as 17 percent "poor", 53 percent "fair", and 30 percent "good". Rotation was indicated as 94 percent "all crops", 1 percent "one-half crops", and 5 percent "two-thirds crops".

Appendix Table 49. COTTON: Normal yield per acre and production practices, deep moderately well drained bottom soils with 41-60 pounds of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	623	623
Pounds of N	100.0	54	54
Pounds of P_2O_5	98.6	47	48
Pounds of K_2O	99.3	48	49
Other practices (times over):			
Flat breaking, fall	1.4	.01	1.00
Flat breaking, spring	68.5	.69	1.00
Middle breaking, fall	2.7	.03	1.00
Middle breaking, spring	65.1	1.16	1.78
Discing, spring	97.3	2.31	2.38
Listing, spring	24.0	.28	1.20
Harrowing	99.3	1.56	1.57
Pre-emerge	62.3	.62	1.00
Post-emerge	2.1	.02	1.33
Hoeing	100.0	2.38	2.38
Cultivation	100.0	6.35	6.35
Insecticides	95.2	9.69	10.18
Defoliation	22.6	.23	1.00

1/ Based upon 146 observations. Farm drainage was indicated as 14 percent "poor", 54 percent "fair", and 32 percent "good". Rotation was indicated as 92 percent "all crops", 1 percent "one-half crops", and 7 percent "two-thirds crops".

Appendix Table 50. COTTON: Normal yield per acre and production practices, deep moderately well drained bottom soils with 61 pounds or more of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	691	691
Pounds of N	100.0	80	80
Pounds of P_2O_5	99.5	51	51
Pounds of K_2O	99.5	51	51
Other practices (times over):			
Flat breaking, spring	68.2	.68	1.00
Middle breaking, fall	1.0	.01	1.00
Middle breaking, spring	72.9	1.31	1.80
Discing, fall	1.6	.02	1.00
Discing, spring	99.5	2.65	2.66
Listing, spring	20.8	.23	1.15
Harrowing	98.4	1.47	1.49
Pre-emerge	81.3	.81	1.00
Post-emerge	12.0	.17	1.47
Hoeing	100.0	2.32	2.32
Flame cultivation	9.9	.30	3.00
Cultivation	100.0	6.41	6.41
Insecticides	99.0	11.34	11.46
Defoliation	46.9	.47	1.00

1/ Based upon 192 observations. Farm drainage was indicated as 2 percent "poor", 49 percent "fair", and 49 percent "good". Rotation was indicated as 92 percent "all crops", 1 percent "one-half crops", and 7 percent "two-thirds crops".

Appendix Table 51. COTTON: Normal yield per acre and production practices, low wet soils with 40 pounds or less of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. lint)	100.0	485	485
Pounds of N	100.0	33	33
Pounds of P_2O_5	100.0	41	41
Pounds of K_2O	100.0	41	41
Other practices (times over):			
Flat breaking, spring	41.7	.42	1.00
Middle breaking, fall	66.7	1.16	1.75
Discing, spring	91.7	2.41	2.63
Listing, spring	33.3	.33	1.00
Harrowing	100.0	2.00	2.00
Pre-emerge	66.7	.67	1.00
Hoeing	100.0	2.50	2.50
Cultivation	100.0	7.16	7.16
Insecticides	100.0	9.41	9.41
Defoliation	25.0	.25	1.00

1/ Based upon 12 observations. Farm drainage was indicated as 67 percent "fair" and 33 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 52. CORN: Normal yield per acre and production practices Adler silt loam, A+, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	71	71
Pounds of N	100.0	88	88
Pounds of P_2O_5	33.3	12	37
Pounds of K_2O	33.3	12	37
Other practices (times over):			
Flat breaking, spring	85.2	.85	1.00
Middle breaking, fall	7.4	.14	2.00
Discing, spring	100.0	3.22	3.22
Listing, spring	3.7	.07	2.00
Harrowing	100.0	1.44	1.44
Pre-emerge	3.7	.04	1.00
Post-emerge	40.7	.41	1.00
Hoeing and thinning	14.8	.15	1.00
Cultivation	100.0	3.14	3.14

1/ Based upon 27 observations. Farm drainage was indicated as 12 percent "poor", 44 percent "fair", and 44 percent "good". Rotation was indicated as 96 percent "all crops" and 4 percent "two-thirds crops".

ppendix Table 53. CORN: Normal yield per acre and production practices, Atwood silt loam, C3, Mississippi Brown Loam Area, 1965.1/

tem	Percentage reporting	Average for all farmers	Average for farmers reporting
ield (bu.)	100.0	51	51
ounds of N	100.0	66	66
ounds of P_2O_5	96.9	32	33
ounds of K_2O	96.9	31	32
ther practices (times over):			
Flat breaking, fall	6.3	.06	1.00
Flat breaking, spring	75.0	.75	1.00
Middle breaking, fall	3.1	.03	1.00
Middle breaking, spring	25.0	.46	1.87
Discing, spring	96.9	2.46	2.54
Listing, spring	12.5	.13	1.00
Harrowing	100.0	1.09	1.09
Pre-emerge	15.6	.16	1.00
Post-emerge	21.9	.22	1.00
Hoeing and thinning	3.1	.03	1.00
Cultivation	100.0	2.84	2.84

1/ Based upon 32 observations. Farm drainage was indicated as 16 percent "poor", 53 percent "fair", and 31 percent "good". Rotation was indicated as 94 percent "all crops", 3 percent "one-half crops", and 3 ercent "two-thirds crops".

ppendix Table 54. CORN: Normal yield per acre and production practices, Bude silt loam, B1 and B2, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	52	52
Pounds of N	100.0	66	66
Pounds of P_2O_5	98.0	38	38
Pounds of K_2O	98.0	36	36
Other practices (times over):			
Flat breaking, fall	4.0	.04	1.00
Flat breaking, spring	42.0	.42	1.00
Middle breaking, fall	2.0	.02	1.00
Middle breaking, spring	66.0	1.28	1.93
Discing, spring	100.0	2.24	2.24
Listing, spring	14.0	.14	1.00
Harrowing	98.0	1.24	1.26
Post-emerge	4.0	.04	1.00
Hoeing and thinning	6.0	.06	1.00
Cultivation	100.0	2.88	2.88

1/ Based upon 50 observations. Farm drainage was indicated as 8 percent "poor", 74 percent "fair", and 18 percent "good". Rotation was indicated as 86 percent "all crops", 8 percent "one-fourth crops", and 6 percent "one-half crops".

Appendix Table 55. CORN: Normal yield per acre and production practices, Calloway silt loam, A+ and A1, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	49	49
Pounds of N	100.0	59	59
Pounds of P_2O_5	72.7	26	36
Pounds of K2O	72.7	26	36
Other practices (times over):			
Flat breaking, spring	81.8	.82	1.00
Middle breaking, spring	27.3	.54	2.00
Discing, fall	18.2	.18	1.00
Discing, spring	100.0	2.45	2.45
Harrowing	100.0	1.45	1.45
Post-emerge	9.1	.09	1.00
Hoeing and thinning	27.3	.27	1.00
Cultivation	100.0	3.45	3.45

1/ Based upon 11 observations. Farm drainage was indicated as 82 percent "fair" and 18 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 56. CORN: Normal yield per acre and production practices, Calloway silt loam, B1 and B2, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	44	44
Pounds of N	100.0	57	57
Pounds of P_2O_5	58.8	24	41
Pounds of K_2O	58.8	23	40
Other practices (times over):			
Flat breaking, spring	64.7	.65	1.00
Middle breaking, spring	41.2	.94	2.28
Discing, fall	5.9	.06	1.00
Discing, spring	94.1	2.34	2.50
Harrowing	94.1	1.58	1.68
Pre-emerge	5.9	.06	1.00
Post-emerge	11.8	.12	1.00
Hoeing and thinning	29.4	.29	1.00
Cultivation	100.0	3.05	3.05

[1] Based upon 17 observations. Farm drainage was indicated as 65 percent "fair" and 35 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 57. CORN: Normal yield per acre and production practices, Collins silt loam, A+ and A1, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	62	62
Pounds of N	95.0	71	75
Pounds of P_2O_5	56.2	21	37
Pounds of K_2O	56.2	21	37
Other practices (times over):			
Flat breaking, spring	71.9	.72	1.01
Middle breaking, spring	38.8	.57	1.48
Discing, spring	95.0	2.54	2.67
Listing, spring	5.8	.07	1.28
Harrowing	98.3	1.42	1.45
Pre-emerge	14.9	.15	1.00
Post-emerge	14.9	.15	1.00
Hoeing and thinning	27.3	.27	1.00
Cultivation	100.0	2.85	2.85

[1] Based upon 121 observations. Farm drainage was indicated as 12 percent "poor", 48 percent "fair, and 40 percent "good". Rotation was indicated as 92 percent "all crops", 1 percent "one-half crops", and 7 percent "two-thirds crops".

Appendix Table 58. CORN: Normal yield per acre and production practices, Collins silt loam, 1.a. and and A+, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	59	59
Pounds of N	97.1	66	68
Pounds of P_2O_5	57.1	22	38
Pounds of K_2O	57.1	22	38
Other practices (times over):			
Flat breaking, fall	1.4	.01	1.00
Flat breaking, spring	60.0	.60	1.00
Middle breaking, spring	45.7	.75	1.65
Discing, spring	94.3	2.10	2.22
Listing, spring	7.1	.07	1.00
Harrowing	97.1	1.32	1.36
Pre-emerge	11.4	.11	1.00
Post-emerge	14.3	.14	1.00
Hoeing and thinning	21.4	.21	1.00
Cultivation	100.0	3.05	3.05

[1] Based upon 70 observations. Farm drainage was indicated as 13 percent "poor", 50 percent "fair", and 37 percent "good". Rotation was indicated as 97 percent "all crops", 1 percent "one-fourth crops", 1 percent "one-half crops", and 1 percent "two-thirds crops".

Appendix Table 59. CORN: Normal yield per acre and production practices, Collins silt loam, 1.a., B+ and B1, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	56	56
Pounds of N	93.3	63	67
Pounds of P_2O_5	40.0	15	37
Pounds of K_2O	40.0	15	37
Other practices (times over):			
Flat breaking, spring	53.3	.53	1.00
Middle breaking, spring	66.7	1.00	1.50
Discing, spring	100.0	2.40	2.40
Listing, spring	20.0	.20	1.00
Harrowing	93.3	1.20	1.28
Pre-emerge	6.7	.07	1.00
Hoeing and thinning	40.0	.40	1.00
Cultivation	100.0	3.20	3.20

1/ Based upon 15 observations. Farm drainage was indicated as 33 percent "poor", 20 percent "fair", and 47 percent "good". Rotation was indicated as 93 percent "all crops" and 7 percent "two-thirds crops".

Appendix Table 60. CORN: Normal yield per acre and production practices, Dulac silt loam, B3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	44	44
Pounds of N	100.0	58	58
Pounds of P_2O_5	96.7	32	33
Pounds of K_2O	93.3	30	32
Other practices (times over):			
Flat breaking, spring	83.3	.83	1.00
Middle breaking, spring	30.0	.53	1.77
Discing, spring	96.7	2.80	2.89
Listing, spring	10.0	.10	1.00
Harrowing	100.0	1.56	1.56
Pre-emerge	6.7	.13	2.00
Post-emerge	3.3	.03	1.00
Hoeing and thinning	10.0	.10	1.00
Cultivation	100.0	3.00	3.00

1/ Based upon 30 observations. Farm drainage was indicated as 10 percent "poor", 60 percent "fair", and 30 percent "good". Rotation was indicated as 93 percent "all crops" and 7 percent "two-thirds crops".

Appendix Table 61. CORN: Normal yield per acre and production practices, Falaya silt loam, A+ and A1, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	56	56
Pounds of N	98.3	66	67
Pounds of P_2O_5	74.0	26	35
Pounds of K_2O	74.1	25	34
Other practices (times over):			
Flat breaking, fall	1.2	.01	1.00
Flat breaking, spring	60.7	.61	1.00
Middle breaking, fall	2.5	.03	1.00
Middle breaking, spring	43.4	.70	1.62
Discing, spring	95.5	2.51	2.62
Listing, spring	19.0	.20	1.06
Harrowing	93.4	1.36	1.46
Pre-emerge	13.2	.13	1.00
Post-emerge	17.4	.18	1.09
Hoeing and thinning	17.3	.18	1.07
Cultivation	100.0	2.91	2.91

1/ Based upon 242 observations. Farm drainage was indicated as 17 percent "poor", 57 percent "fair", and 26 percent "good". Rotation was indicated as 88 percent "all crops", 3 percent "one-fourth crops", 2 percent "one-half crops". and 7 percent "two-thirds crops".

Appendix Table 62. **CORN: Normal yield per acre and production practices, Falaya silt loam, 1.a. and A+, Mississippi Brown Loam Area, 1965.**[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	58	58
Pounds of N	100.0	71	71
Pounds of P_2O_5	53.6	20	37
Pounds of K_2O	53.6	20	37
Other practices (times over):			
Flat breaking, spring	57.1	.57	1.00
Middle breaking, spring	57.1	1.03	1.81
Discing, spring	85.7	1.92	2.25
Listing, spring	10.7	.11	1.00
Harrowing	96.4	1.71	1.77
Pre-emerge	17.9	.18	1.00
Post-emerge	10.7	.11	1.00
Hoeing and thinning	32.1	.35	1.09
Cultivation	100.0	2.89	2.89

[1] Based upon 28 observations. Farm drainage was indicated as 11 percent "poor", 78 percent "fair", and 11 percent "good". Rotation was indicated as 96 percent "all crops" and 4 percent "two-thirds crops".

Appendix Table 63. **CORN: Normal yield per acre and production practices, Falaya silt loam, 1.a. and B+, Mississippi Brown Loam Area, 1965.**[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	61	61
Pounds of N	100.0	81	81
Pounds of P_2O_5	96.0	36	37
Pounds of K_2O	96.0	36	37
Other practices (times over):			
Flat breaking, fall	4.0	.04	1.00
Flat breaking, spring	76.0	.76	1.00
Middle breaking, spring	24.0	.48	2.00
Discing, spring	96.0	2.64	2.75
Listing, spring	24.0	.24	1.00
Harrowing	100.0	1.52	1.52
Pre-emerge	16.0	.16	1.00
Post-emerge	4.0	.04	1.00
Hoeing and thinning	4.0	.04	1.00
Cultivation	100.0	2.92	2.92

[1] Based upon 25 observations. Farm drainage was indicated as 4 percent "poor", 48 percent "fair", and 48 percent "good". Rotation was indicated as 60 percent "all crops", 8 percent "one-half crops", and 32 percent "two-thirds crops".

Appendix Table 64. **CORN: Normal yield per acre and production practices, Falkner silt loam, B2, Mississippi Brown Loam Area, 1965.**[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	32	32
Pounds of N	100.0	41	41
Pounds of P_2O_5	92.3	23	25
Pounds of K_2O	92.3	21	23
Other practices (times over):			
Flat breaking, fall	3.8	.04	1.00
Flat breaking, spring	61.5	.62	1.00
Middle breaking, fall	3.8	.04	1.00
Middle breaking, spring	26.9	.50	1.85
Discing, fall	3.8	.04	1.00
Discing, spring	100.0	2.65	2.65
Listing, spring	15.4	.19	1.25
Harrowing	100.0	1.84	1.84
Hoeing and thinning	7.7	.08	1.00
Cultivation	100.0	3.26	3.26

[1] Based upon 26 observations. Farm drainage was indicated as 88 percent "fair" and 12 percent "good". Rotation was indicated as 60 percent "all crops", 8 percent "one-half crops", and 32 percent "two-thirds crops".

Appendix Table 65. CORN: Normal yield per acre and production practices, Grenada silt loam, A1, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	49	49
Pounds of N	92.3	77	84
Pounds of P_2O_5	69.2	43	63
Pounds of K_2O	69.2	43	63
Other practices (times over):			
Flat breaking, spring	69.2	.69	1.00
Middle breaking, spring	92.3	1.53	1.67
Discing, spring	92.3	2.07	2.25
Listing, spring	7.7	.08	1.00
Harrowing	100.0	1.61	1.61
Pre-emerge	46.2	.46	1.00
Post-emerge	23.1	.38	1.67
Hoeing and thinning	30.8	.31	1.00
Cultivation	100.0	3.08	3.08

[1] Based upon 13 observations. Farm drainage was indicated as 46 percent "fair and 54 percent "good". Rotation was indicated as 77 percent "all crops" and 23 percent "two-thirds crops".

Appendix Table 66. CORN: Normal yield per acre and production practices, Grenada silt loam, B2, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	40	40
Pounds of N	98.5	55	56
Pounds of P_2O_5	58.8	16	28
Pounds of K_2O	58.8	16	28
Other practices (times over):			
Flat breaking, fall	1.5	.02	1.00
Flat breaking, spring	52.9	.53	1.00
Middle breaking, spring	60.3	1.08	1.80
Discing, spring	83.8	1.91	2.28
Listing, spring	7.4	.07	1.00
Harrowing	98.5	1.52	1.55
Pre-emerge	1.5	.01	1.00
Post-emerge	2.9	.03	1.00
Hoeing and thinning	22.1	.22	1.00
Cultivation	100.0	3.25	3.25

[1] Based upon 68 observations. Farm drainage was indicated as 7 percent "poor", 80 percent "fair", and 13 percent "good". Rotation was indicated as 96 percent "all crops", 3 percent "one-half crops", and 1 percent "two-thirds crops".

Appendix Table 67. CORN: Normal yield per acre and production practices, Grenada silt loam, B3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	33	33
Pounds of N	98.2	45	46
Pounds of P_2O_5	74.5	21	28
Pounds of K_2O	72.7	19	27
Other practices (times over):			
Flat breaking, spring	32.7	.33	1.00
Middle breaking, fall	1.8	.02	1.00
Middle breaking, spring	81.8	1.69	2.06
Discing, spring	70.9	1.41	2.00
Listing, spring	10.9	.21	2.00
Harrowing	98.2	1.47	1.50
Pre-emerge	3.6	.04	1.00
Post-emerge	1.8	.02	1.00
Hoeing and thinning	43.6	.44	1.00
Cultivation	100.0	3.25	3.25

[1] Based upon 55 observations. Farm drainage was indicated as 6 percent "poor", 87 percent "fair", and 7 percent "good". Rotation was indicated as 98 percent "all crops" and 2 percent "one-half crops".

Appendix Table 68. CORN: Normal yield per acre and production practices, Grenada silt loam, C3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	30	30
Pounds of N	100.0	34	34
Pounds of P_2O_5	43.5	11	26
Pounds of K_2O	43.5	10	23
Other practices (times over):			
Flat breaking, fall	4.3	.04	1.00
Flat breaking, spring	21.7	.22	1.00
Middle breaking, fall	4.3	.04	1.00
Middle breaking, spring	91.3	1.52	1.67
Discing, spring	82.6	1.60	1.94
Listing, spring	8.7	.13	1.50
Harrowing	100.0	1.52	1.52
Hoeing and thinning	47.8	.48	1.00
Cultivation	100.0	3.60	3.60

1/ Based upon 23 observations. Farm drainage was indicated as 4 percent "poor", 83 percent "fair", and 13 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 69. CORN: Normal yield per acre and production practices, Hatchie silt loam, Al, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	42	42
Pounds of N	88.9	42	48
Pounds of P_2O_5	88.9	29	32
Pounds of K_2O	88.9	29	32
Other practices (times over):			
Flat breaking, spring	61.1	.61	1.00
Middle breaking, spring	61.1	.88	1.45
Discing, spring	100.0	2.55	2.55
Listing, spring	50.0	.67	1.33
Harrowing	88.9	1.66	1.87
Hoeing and thinning	22.2	.22	1.00
Cultivation	100.0	3.33	3.33

1/ Based upon 18 observations. Farm drainage was indicated as 5 percent "poor", 28 percent "fair", and 67 percent "good". Rotation was indicated as 78 percent "all crops" and 22 percent "two-thirds crops".

Appendix Table 70. CORN: Normal yield per acre and production practices, Inglefield silt loam, At, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	67	67
Pounds of N	100.0	81	81
Pounds of P_2O_5	10.5	4	40
Pounds of K_2O	10.5	4	40
Other practices (times over):			
Flat breaking, spring	63.2	.63	1.00
Middle breaking, fall	5.3	.05	1.00
Middle breaking, spring	31.6	.47	1.50
Discing, spring	100.0	3.63	3.63
Harrowing	100.0	1.36	1.36
Post-emerge	52.6	.53	1.00
Hoeing and thinning	42.1	.42	1.00
Cultivation	100.0	3.09	3.09

1/ Based upon 19 observations. Farm drainage was indicated as 11 percent "poor", 5 percent "fair", and 84 percent "good". Rotation was indicated as 79 percent "all crops", 5 percent "one-half crops", and 16 percent "two-thirds crops".

Appendix Table 71. CORN: Normal yield per acre and production practices, Loring silt loam, B2, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	33	33
Pounds of N	97.6	44	45
Pounds of P_2O_5	47.6	12	26
Pounds of K_2O	47.6	12	26
Other practices (times over):			
Flat breaking, fall	4.8	.05	1.00
Flat breaking, spring	50.0	.50	1.00
Middle breaking, spring	71.4	1.16	1.63
Discing, spring	83.3	1.97	2.37
Harrowing	100.0	1.50	1.50
Pre-emerge	2.4	.02	1.00
Post-emerge	2.4	.02	1.00
Hoeing and thinning	38.1	.38	1.00
Cultivation	100.0	3.39	3.39

1/ Based upon 42 observations. Farm drainage was indicated as 2 percent "poor", 88 percent "fair", and 10 percent "good". Rotation was indicated as 90 percent "all crops", 2 percent "one-fourth crops", 2 percent "one-half crops", and 5 percent "two-thirds crops".

Appendix Table 72. CORN: Normal yield per acre and production practices, Loring silt loam, B3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	37	37
Pounds of N	100.0	49	49
Pounds of P_2O_5	65.2	18	27
Pounds of K_2O	65.2	18	27
Other practices (times over):			
Flat breaking, spring	34.8	.35	1.00
Middle breaking, fall	4.3	.04	1.00
Middle breaking, spring	73.9	1.39	1.88
Discing, spring	78.3	1.78	2.27
Listing, spring	8.7	.09	1.00
Harrowing	100.0	1.39	1.39
Pre-emerge	4.3	.04	1.00
Hoeing and thinning	39.1	.39	1.00
Cultivation	100.0	3.52	3.52

1/ Based upon 23 observations. Farm drainage was indicated as 9 percent "poor", 69 percent "fair", and 22 percent "good". Rotation was indicated as 96 percent "all crops" and 4 percent "one-fourth crops".

Appendix Table 73. CORN: Normal yield per acre and production practices, Loring silt loam, C3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	31	31
Pounds of N	92.9	42	45
Pounds of P_2O_5	42.9	13	31
Pounds of K_2O	42.9	13	31
Other practices (times over):			
Flat breaking, spring	25.0	.25	1.00
Middle breaking, fall	3.6	.04	1.00
Middle breaking, spring	85.7	1.39	1.62
Discing, spring	89.3	1.89	2.12
Harrowing	96.4	1.14	1.18
Post-emerge	3.6	.04	1.00
Hoeing and thinning	32.1	.36	1.11
Cultivation	100.0	3.50	3.50

1/ Based upon 28 observations. Farm drainage was indicated as 7 percent "poor", 72 percent "fair", and 21 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 74. CORN: Normal yield per acre and production practices, Loring silty clay loam, C3, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	28	28
Pounds of N	100.0	38	38
Pounds of P_2O_5	25.0	5	21
Pounds of K_2O	25.0	5	21
Other practices (times over):			
Flat breaking, spring	83.3	.83	1.00
Middle breaking, spring	66.7	1.00	1.50
Discing, spring	83.3	2.08	2.50
Harrowing	100.0	1.67	1.67
Hoeing and thinning	50.0	.50	1.00
Cultivation	100.0	3.50	3.50

1/ Based upon 12 observations. Farm drainage was indicated as 25 percent "poor" and 75 percent "fair". Rotation was indicated as 100 percent "all crops".

Appendix Table 75. CORN: Normal yield per acre and production practices, Memphis silt loam, A1, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	58	58
Pounds of N	100.0	76	76
Pounds of P_2O_5	45.2	18	40
Pounds of K_2O	45.2	18	40
Other practices (times over):			
Flat breaking, spring	77.4	.77	1.00
Middle breaking, fall	3.2	.03	1.00
Middle breaking, spring	35.5	.51	1.45
Discing, fall	6.5	.07	1.00
Discing, spring	100.0	2.87	2.87
Listing, fall	3.2	.03	1.00
Listing, spring	6.5	.07	1.00
Harrowing	100.0	1.45	1.45
Pre-emerge	3.2	.03	1.00
Post-emerge	45.2	.45	1.00
Hoeing and thinning	22.6	.23	1.00
Cultivation	100.0	2.74	2.74

1/ Based upon 31 observations. Farm drainage was indicated as 35 percent "fair" and 65 percent "good". Rotation was indicated as 90 percent "all crops", 3 percent "one-half crops", and 7 percent "two-thirds crops".

Appendix Table 76. CORN: Normal yield per acre and production practices, Memphis silt loam, B1 and B2, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	38	38
Pounds of N	95.5	55	58
Pounds of P_2O_5	34.1	11	31
Pounds of K_2O	34.1	11	31
Other practices (times over):			
Flat breaking, spring	63.6	.64	1.00
Middle breaking, spring	45.5	.64	1.40
Discing, spring	95.5	2.75	2.88
Listing, spring	4.5	.05	1.00
Harrowing	100.0	1.38	1.38
Post-emerge	20.5	.21	1.00
Hoeing and thinning	31.8	.34	1.07
Cultivation	100.0	3.27	3.27

1/ Based upon 44 observations. Farm drainage was indicated as 2 percent "poor", 77 percent "fair", and 21 percent "good". Rotation was indicated as 93 percent "all crops, 2 percent "one-half crops", and 5 percent "two-thirds crops".

Appendix Table 77. CORN: Normal yield per acre and production practices, Memphis silt loam, B3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	31	31
Pounds of N	98.1	42	43
Pounds of P_2O_5	9.3	3	30
Pounds of K_2O	9.3	3	30
Other practices (times over):			
Flat breaking, spring	31.5	.32	1.00
Middle breaking, fall	3.7	.04	1.00
Middle breaking, spring	70.4	.96	1.36
Discing, spring	98.1	2.42	2.47
Listing, spring	3.7	.07	2.00
Harrowing	100.0	1.38	1.38
Post-emerge	1.9	.02	1.00
Hoeing and thinning	79.6	.80	1.00
Cultivation	100.0	3.53	3.53

[1] Based upon 54 observations. Farm drainage was indicated as 9 percent "poor", 72 percent "fair", and 19 percent "good". Rotation was indicated as 98 percent "all crops" and 2 percent "one-fourth crops".

Appendix Table 78. CORN: Normal yield per acre and production practices, Memphis silt loam, C3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	32	32
Pounds of N	100.0	43	43
Pounds of P_2O_5	30.4	8	28
Pounds of K_2O	30.4	8	28
Other practices (times over):			
Flat breaking, spring	26.1	.26	1.00
Middle breaking, spring	65.2	.95	1.46
Discing, spring	100.0	2.91	2.91
Harrowing	100.0	1.56	1.56
Hoeing and thinning	52.2	.52	1.00
Cultivation	100.0	3.34	3.34

[1] Based upon 23 observations. Farm drainage was indicated as 26 percent "poor", 61 percent "fair", and 13 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 79. CORN: Normal yield per acre and production practices, Memphis and Loring silt loam, B2 and B3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	32	32
Pounds of N	88.9	36	40
Pounds of P_2O_5	22.2	11	49
Pounds of K_2O	22.2	11	49
Other practices (times over:			
Flat breaking, spring	27.8	.28	1.00
Middle breaking, spring	72.2	1.11	1.53
Discing, spring	94.4	2.55	2.70
Harrowing	100.0	1.50	1.50
Post-emerge	5.6	.06	1.00
Hoeing and thinning	50.0	.50	1.00
Cultivation	100.0	3.38	3.38

[1] Based upon 18 observations. Farm drainage was indicated as 6 percent "poor" and 94 percent "fair". Rotation was indicated as 94 percent "all crops" and 6 percent "one-fourth crops".

Appendix Table 80. CORN: Normal yield per acre and production practices, Providence silt loam, B2, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield(bu.)	100.0	54	54
Pounds of N	100.0	70	70
Pounds of P_2O_5	96.2	33	34
Pounds of K_2O	96.2	33	34
Other practices (time over):			
Flat breaking, spring	45.3	.45	1.00
Middle breaking, spring	73.6	1.52	2.07
Discing, spring	92.5	2.07	2.24
Listing, spring	7.5	.08	1.00
Harrowing	88.7	1.09	1.23
Post-emerge	3.8	.04	1.00
Hoeing and thinning	15.1	.15	1.00
Cultivation	100.0	2.77	2.77

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[1] Based upon 53 observations. Farm drainage was indicated as 69 percent "fair" and 31 percent "good". Rotation was indicated as 92 percent "all crops", 4 percent "one-half crops", and 4 percent "two-thirds crops".

Appendix Table 81. CORN: Normal yield per acre and production practices, Providence silt loam, B3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	45	45
Pounds of N	100.0	67	67
Pounds of P_2O_5	90.9	27	30
Pounds of K_2O	90.9	27	30
Other practices (times over):			
Flat breaking, spring	45.5	.46	1.00
Middle breaking, spring	63.6	1.36	2.14
Discing, spring	90.9	2.13	2.35
Harrowing	100.0	1.31	1.31
Post-emerge	4.5	.05	1.00
Hoeing and thinning	9.1	.09	1.00
Cultivation	100.0	3.09	3.09

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[1] Based upon 22 observations. Farm drainage was indicated as 9 percent "poor", 68 percent "fair", and 23 percent "good". Rotation was indicated as 81 percent "all crops", 9 percent "one-fourth crops", 5 percent "one-half crops", and 5 percent "two-thirds crops".

Appendix Table 82. CORN: Normal yield per acre and production practices, Providence silt loam, C3, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	35	35
Pounds of N	100.0	52	52
Pounds of P_2O_5	80.0	23	29
Pounds of K_2O	80.0	21	26
Other practices (times over):			
Flat breaking, spring	80.0	.80	1.00
Middle breaking, spring	32.0	.44	1.37
Discing, spring	92.0	2.24	2.43
Listing, spring	4.0	.04	1.00
Harrowing	100.0	1.32	1.32
Pre-emerge	4.0	.04	1.00
Hoeing and thinning	44.0	.44	1.00
Cultivation	100.0	2.96	2.96

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[1] Based upon 25 observations. Farm drainage was indicated as 8 percent "poor", 76 percent "fair", and 16 percent "good". Rotation was indicated as 88 percent "all crops", 4 percent "one-half crops", and 8 percent "two-thirds crops".

Appendix Table 83. CORN: Normal yield per acre and production practices, Richland silt loam, A1 and A2, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	47	47
Pounds of N	100.0	60	60
Pounds of P_2O_5	57.1	19	33
Pounds of K_2O	57.1	19	33
Other practices (times over):			
Flat breaking, spring	50.0	.50	1.00
Middle breaking, spring	71.4	1.50	2.10
Discing, spring	85.7	2.07	2.41
Harrowing	92.9	1.28	1.38
Hoeing and thinning	28.6	.29	1.00
Cultivation	100.0	3.14	3.14

1/ Based upon 14 observations. Farm drainage was indicated as 86 percent "fair" and 14 percent "good". Rotation was indicated as 88 percent "all crops", 4 percent "one-half crops", and 8 percent "two-thirds crops".

Appendix Table 84. CORN: Normal yield per acre and production practices, Richland silt loam, B2, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	45	45
Pounds of N	100.0	58	58
Pounds of P_2O_5	45.5	11	24
Pounds of K_2O	45.5	11	24
Other practices (times over):			
Flat breaking, spring	27.3	.27	1.00
Middle breaking, fall	9.1	.09	1.00
Middle breaking, spring	72.7	1.72	2.37
Discing, spring	81.8	1.81	2.22
Listing, spring	18.2	.27	1.50
Harrowing	90.9	1.27	1.40
Pre-emerge	9.1	.09	1.00
Post-emerge	27.3	.27	1.00
Hoeing and thinning	27.3	.27	1.00
Cultivation	100.0	3.18	3.18

1/ Based upon 11 observations. Farm drainage was indicated as 55 percent "fair" and 45 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 85. CORN: Normal yield per acre and production practices, Urbo silty clay loam, A+, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	42	42
Pounds of N	94.4	44	47
Pounds of P_2O_5	94.4	35	37
Pounds of K_2O	94.4	35	37
Other practices (times over):			
Flat breaking, spring	77.8	.78	1.00
Middle breaking, fall	5.6	.06	1.00
Middle breaking, spring	11.1	.11	1.00
Discing, spring	100.0	2.50	2.50
Listing, spring	22.2	.22	1.00
Harrowing	100.0	1.77	1.77
Pre-emerge	5.6	.06	1.00
Post-emerge	5.6	.06	1.00
Hoeing and thinning	16.7	.22	1.33
Cultivation	100.0	3.11	3.11

1/ Based upon 18 observations. Farm drainage was indicated as 5 percent "poor", 67 percent "fair", and 28 percent "good". Rotation was indicated as 88 percent "all crops", 6 percent "one-half crops", and 6 percent "two-thirds crops".

Appendix Table 86. CORN: Normal yield per acre and production practices, dry sloping hill soils with 40 pounds or less of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	25	25
Pounds of N	97.0	27	28
Pounds of P_2O_5	34.8	8	23
Pounds of K_2O	34.8	8	23
Other practices (times over):			
Flat breaking, fall	1.5	.02	1.00
Flat breaking, spring	34.8	.35	1.00
Middle breaking, fall	4.5	.05	1.00
Middle breaking, spring	83.3	1.30	1.56
Discing, spring	89.4	1.98	2.22
Listing, spring	6.1	.07	1.25
Harrowing	98.5	1.48	1.50
Hoeing and thinning	56.0	.58	1.03
Cultivation	100.0	3.60	3.60

1/ Based upon 66 observations. Farm drainage was indicated as 23 percent "poor", 64 percent "fair", and 13 percent "good". Rotation was indicated as 96 percent "all crops", 2 percent "one-half crops", and 2 percent "two-thirds crops".

Appendix Table 87. CORN: Normal yield per acre and production practices, dry sloping hill soils with 41-60 pounds of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	36	36
Pounds of N	100.0	50	50
Pounds of P_2O_5	86.1	27	31
Pounds of K_2O	86.1	25	29
Other practices (times over):			
Flat breaking, spring	69.4	.69	1.00
Middle breaking, spring	41.7	.72	1.73
Discing, spring	88.9	2.16	2.43
Harrowing	100.0	1.33	1.33
Pre-emerge	5.6	.06	1.00
Post-emerge	11.1	.11	1.00
Hoeing and thinning	25.0	.25	1.00
Cultivation	100.0	3.00	3.00

1/ Based upon 36 observations. Farm drainage was indicated as 5 percent "poor", 78 percent "fair", and 17 percent "good". Rotation was indicated as 100 percent "all crops".

Appendix Table 88. CORN: Normal yield per acre and production practices, dry sloping hill soils with 61 pounds or more of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	54	54
Pounds of N	100.0	80	80
Pounds of P_2O_5	70.7	24	34
Pounds of K_2O	70.7	23	33
Other practices (times over):			
Flat breaking, fall	4.9	.05	1.00
Flat breaking, spring	58.5	.59	1.00
Middle breaking, spring	34.1	.53	1.57
Discing, spring	97.6	2.63	2.70
Listing, spring	7.3	.07	1.00
Harrowing	100.0	1.09	1.09
Pre-emerge	9.8	.10	1.00
Post-emerge	9.8	.10	1.00
Hoeing and thinning	9.7	.10	1.00
Cultivation	100.0	2.90	2.90

1/ Based upon 41 observations. Farm drainage was indicated as 5 percent "poor", 68 percent "fair", and 27 percent "good". Rotation was indicated as 93 percent "all crops", 2 percent "one-half crops", and 5 percent "two-thirds crops".

Appendix Table 89. CORN: Normal yield per acre and production practices, deep moderately well drained upland and bench soils with 40 pounds or less of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	26	26
Pounds of N	94.8	26	28
Pounds of P_2O_5	34.5	7	21
Pounds of K_2O	33.3	7	21
Other practices (times over):			
Flat breaking, spring	34.5	.35	1.00
Middle breaking, fall	1.7	.02	1.00
Middle breaking, spring	77.6	1.36	1.76
Discing, spring	78.2	1.77	2.27
Listing, spring	6.9	.13	2.00
Harrowing	98.9	1.59	1.61
Pre-emerge	.6	.01	1.00
Hoeing and thinning	59.8	.60	1.00
Cultivation	100.0	3.53	3.53

1/ Based upon 174 observations. Farm drainage was indicated as 6 percent "poor", 81 percent "fair", and 13 percent "good". Rotation was indicated as 97 percent "all crops, 1 percent "one-fourth crops", 1 percent "one-half crops", and 1 percent "two-thirds crops".

Appendix Table 90. CORN: Normal yield per acre and production practices, deep moderately well drained upland and bench soils with 41-60 pounds of nitrogen applied, Mississippi Brown Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	41	41
Pounds of N	100.0	52	52
Pounds of P_2O_5	75.6	22	29
Pounds of K_2O	75.6	22	29
Other practices (times over):			
Flat breaking, spring	50.4	.50	1.00
Middle breaking, spring	67.5	1.25	1.85
Discing, spring	90.2	2.08	2.31
Listing, spring	8.1	.09	1.20
Harrowing	96.7	1.29	1.33
Pre-emerge	1.6	.02	1.00
Post-emerge	4.1	.04	1.00
Hoeing and thinning	30.9	.31	1.00
Cultivation	100.0	3.08	3.08

1/ Based upon 123 observations. Farm drainage was indicated as 7 percent "poor", 67 percent "fair", and 26 percent "good". Rotation was indicated as 95 percent "all crops", 1 percent "one-fourth crops", 2 percent "one-half crops", and 2 percent "two-thirds crops".

Appendix Table 91. CORN: Normal yield per acre and production practices, deep moderately well drained upland and bench soils with 61 pounds or more of nitrogen applied, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	55	55
Pounds of N	100.0	85	85
Pounds of P_2O_5	68.6	27	39
Pounds of K_2O	68.6	26	38
Other practices (times over):			
Flat breaking, spring	63.8	.64	1.00
Middle breaking, fall	1.6	.02	1.00
Middle breaking, spring	47.6	.84	1.78
Discing, fall	1.1	.01	1.00
Discing, spring	97.3	2.61	2.68
Listing, spring	4.3	.04	1.00
Harrowing	97.8	1.31	1.34
Pre-emerge	7.6	.08	1.00
Post-emerge	18.4	.19	1.05
Hoeing and thinning	9.2	.09	1.00
Cultivation	100.0	2.90	2.90

1/ Based upon 185 observations. Farm drainage was indicated as 2 percent "poor", 69 percent "fair", and 29 percent "good". Rotation was indicated as 90 percent "all crops", 2 percent "one-fourth crops", 3 percent "one-half crops", and 5 percent "two-thirds crops".

Appendix Table 92. CORN: Normal yield per acre and production practices, somethat poorly drained upland and bench soils with 40 pounds or less of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	30	30
Pounds of N	94.4	29	31
Pounds of P_2O_5	75.9	20	27
Pounds of K_2O	75.9	19	26
Other practices (times over):			
Flat breaking, fall	1.9	.02	1.00
Flat breaking, spring	48.1	.48	1.00
Middle breaking, spring	59.3	1.24	2.09
Discing, spring	92.6	2.01	2.18
Listing, spring	16.7	.22	1.33
Harrowing	96.3	1.70	1.76
Hoeing and thinning	37.0	.37	1.00
Cultivation	100.0	3.44	3.44

[1] Based upon 54 observations. Farm drainage was indicated as 13 percent "poor", 72 percent "fair", and 15 percent "good". Rotation was indicated as 91 percent "all crops", 2 percent "one-half crops", and 7 percent "two-thirds crops".

Appendix Table 93. CORN: Normal yield per acre and production practices, somewhat poorly drained upland and bench soils with 41-60 pounds of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	44	44
Pounds of N	100.0	54	54
Pounds of P_2O_5	95.5	34	36
Pounds of K_2O	95.5	34	36
Other practices (times over):			
Flat breaking, fall	2.3	.02	1.00
Flat breaking, spring	52.3	.52	1.00
Middle breaking, fall	2.3	.02	1.00
Middle breaking, spring	61.4	1.06	1.74
Discing, fall	4.5	.05	1.00
Discing, spring	100.0	2.50	2.50
Listing, fall	13.6	.15	1.16
Harrowing	97.7	1.52	1.55
Pre-emerge	2.3	.02	1.00
Post-emerge	2.3	.02	1.00
Hoeing and thinning	6.8	.07	1.00
Cultivation	100.0	3.02	3.02

[1] Based upon 44 observations. Farm drainage was indicated as 2 percent "poor", 77 percent "fair", and 21 percent "good". Rotation was indicated as 82 percent "all crops", 4 percent "one-fourth crops", 7 percent "one-half crops", and 7 percent "two-thirds crops".

Appendix Table 94. CORN: Normal yield per acre and production practices, somewhat poorly drained upland and bench soils with 61 pounds or more of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	57	57
Pounds of N	100.0	82	82
Pounds of P_2O_5	85.1	33	39
Pounds of K_2O	85.1	32	38
Other practices (times over):			
Flat breaking, fall	2.1	.02	1.00
Flat breaking, spring	63.8	.64	1.00
Middle breaking, fall	2.1	.02	1.00
Middle breaking, spring	44.7	.78	1.76
Discing, fall	4.2	.04	1.00
Discing, spring	100.0	2.40	2.40
Listing, spring	17.0	.19	1.12
Harrowing	93.6	1.21	1.29
Pre-emerge	4.2	.04	1.00
Post-emerge	8.5	.08	1.00
Hoeing and thinning	6.4	.06	1.00
Cultivation	100.0	2.87	2.87

[1] Based upon 47 observations. Farm drainage was indicated as 6 percent "poor", 60 percent "fair", and 34 percent "good". Rotation was indicated as 89 percent "all crops", 7 percent "one-fourth crops", and 4 percent "two-thirds crops".

Appendix Table 95. CORN: Normal yield per acre and production practices, deep moderately well drained bottom soils with 40 pounds or less of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	38	38
Pounds of N	86.5	26	30
Pounds of P_2O_5	39.6	11	27
Pounds of K_2O	39.6	10	26
Other practices (times over):			
Flat breaking, spring	42.7	.43	1.00
Middle breaking, spring	67.7	1.14	1.69
Discing, spring	87.5	1.97	2.26
Listing, spring	17.7	.19	1.11
Harrowing	97.9	1.60	1.63
Pre-emerge	2.1	.02	1.00
Post-emerge	4.2	.04	1.00
Hoeing and thinning	41.7	.48	1.15
Cultivation	100.0	3.26	3.26

[1] Based upon 96 observations. Farm drainage was indicated as 29 percent "poor", 50 percent "fair", and 21 percent "good". Rotation was indicated as 97 percent "all crops" and 3 percent "two-thirds crops".

Appendix Table 96. CORN: Normal yield per acre and production practices, deep moderately well drained bottom soils with 41-60 pounds of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	54	54
Pounds of N	100.0	53	53
Pounds of P_2O_5	86.0	27	32
Pounds of K_2O	86.0	27	32
Other practices (times over):			
Flat breaking, spring	68.6	.69	1.00
Middle breaking, fall	3.3	.03	1.00
Middle breaking, spring	37.2	.61	1.64
Discing, spring	93.4	2.42	2.59
Listing, spring	14.0	.16	1.17
Harrowing	97.5	1.46	1.50
Pre-emerge	7.4	.07	1.00
Post-emerge	8.3	.10	1.30
Hoeing and thinning	21.5	.22	1.03
Cultivation	100.0	3.01	3.01

[1] Based upon 121 observations. Farm drainage was indicated as 18 percent "poor", 52 percent "fair", and 30 percent "good". Rotation was indicated as 88 percent "all crops", 1 percent "one-fourth crops", 1 percent "one-half crops", and 10 percent "two-thirds crops".

Appendix Table 97. CORN: Normal yield per acre and production practices, deep moderately well drained bottom soils with 61 pounds or more of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	67	67
Pounds of N	100.0	88	88
Pounds of P_2O_5	61.1	24	40
Pounds of K_2O	61.1	24	40
Other practices (times over):			
Flat breaking, fall	1.2	.01	1.00
Flat breaking, spring	69.6	.70	1.00
Middle breaking, spring	34.7	.54	1.57
Discing, spring	98.2	2.69	2.74
Listing, spring	11.2	.11	1.02
Harrowing	94.8	1.31	1.39
Pre-emerge	17.6	.17	1.00
Post-emerge	24.6	.25	1.00
Hoeing and thinning	15.8	.16	1.00
Cultivation	100.0	2.82	2.82

[1] Based upon 329 observations. Farm drainage was indicated as 9 percent "poor", 51 percent "fair", and 40 percent "good". Rotation was indicated as 87 percent "all crops", 2 percent "one-fourth crops", 3 percent "one-half crops", and 8 percent "two-thirds crops".

Appendix Table 98. CORN: Normal yield per acre and production practices, low wet soils with 40 pounds or less of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	32	32
Pounds of N	93.8	26	28
Pounds of P_2O_5	93.8	30	32
Pounds of K_2O	93.8	30	32
Other practices (times over):			
Flat breaking, spring	50.0	.50	1.00
Middle breaking, spring	43.8	.75	1.71
Discing, spring	93.8	2.31	2.46
Listing, spring	25.0	.31	1.25
Harrowing	100.0	1.81	1.81
Pre-emerge	6.3	.06	1.00
Hoeing and thinning	43.8	.50	1.14
Cultivation	100.0	3.25	3.25

[1] Based upon 16 observations. Farm drainage was indicated as 6 percent "poor", 63 percent "fair", and 31 percent "good". Rotation was indicated as 94 percent "all crops" and 6 percent "one-half crops".

Appendix Table 99. CORN: Normal yield per acre and production practices, low wet soils with 41-60 pounds of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	44	44
Pounds of N	100.0	53	53
Pounds of P_2O_5	100.0	34	34
Pounds of K_2O	100.0	31	31
Other practices (times over):			
Flat breaking, spring	69.2	.69	1.00
Middle breaking, fall	7.7	.08	1.00
Middle breaking, spring	23.1	.38	1.67
Discing, spring	100.0	2.61	2.61
Listing, spring	23.1	.23	1.00
Harrowing	100.0	1.76	1.76
Post-emerge	7.7	.08	1.00
Cultivation	100.0	3.07	3.07

[1] Based upon 13 observations. Farm drainage was indicated as 92 percent "fair" and 8 percent "good". Rotation was indicated as 77 percent "all crops", 8 percent "one-half crops", and 15 percent "two-thirds crops"

Appendix Table 100. CORN: Normal yield per acre and production practices, low wet soils with 61 pounds or more of nitrogen applied, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	52	52
Pounds of N	100.0	103	103
Pounds of P_2O_5	100.0	41	41
Pounds of K_2O	100.0	41	41
Other practices (times over):			
Flat breaking, spring	80.0	.80	1.00
Middle breaking, spring	40.0	.70	1.75
Discing, spring	90.0	2.40	2.66
Harrowing	100.0	1.70	1.70
Pre-emerge	30.0	.30	1.00
Post-emerge	20.0	.20	1.00
Hoeing and thinning	20.0	.20	1.00
Cultivation	100.0	2.50	2.50

[1] Based upon 10 observations. Farm drainage was indicated as 10 percent "poor", 70 percent "fair", and 20 percent "good". Rotation was indicated as 80 percent "all crops", 10 percent "one-half crops", and 10 percent "two-thirds crops".

Appendix Table 101. CORN: Normal yield per acre and production practices, all dry sloping hill soils, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	36	36
Pounds of N	98.6	48	48
Pounds of P_2O_5	58.0	17	30
Pounds of K_2O	58.0	17	30
Other practices (times over):			
Flat breaking, fall	2.1	.02	1.00
Flat breaking, spring	50.3	.50	1.00
Middle breaking, fall	2.1	.02	1.00
Middle breaking, spring	58.7	.93	1.59
Discing, spring	91.6	2.21	2.41
Listing, spring	4.9	.05	1.14
Harrowing	99.3	1.33	1.34
Pre-emerge	4.2	.04	1.00
Post-emerge	5.6	.06	1.00
Hoeing and thinning	34.0	.35	1.04
Cultivation	100.0	3.25	3.25

[1] Based upon 143 observations. Farm drainage was indicated as 13 percent "poor", 69 percent "fair", and 18 percent "good". Rotation was indicated as 97 percent "all crops", 1 percent "one-half crops", and 2 percent "two-thirds crops".

Appendix Table 102. CORN: Normal yield per acre and production practices, all deep moderately well drained upland and bench soils, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	41	41
Pounds of N	98.1	55	56
Pounds of P_2O_5	58.1	19	32
Pounds of K_2O	57.7	18	31
Other practices (times over):			
Flat breaking, spring	50.0	.50	1.00
Middle breaking, fall	1.2	.01	1.00
Middle breaking, spring	63.5	1.13	1.79
Discing, spring	88.6	2.17	2.45
Listing, spring	6.2	.09	1.46
Harrowing	97.9	1.41	1.43
Pre-emerge	3.5	.04	1.00
Post-emerge	8.1	.08	1.05
Hoeing and thinning	33.0	.33	1.01
Cultivation	100.0	3.17	3.17

[1] Based upon 482 observations. Farm drainage was indicated as 5 percent "poor", 73 percent "fair", and 22 percent "good". Rotation was indicated as 94 percent "all crops", 1 percent "one-fourth crops", 2 percent "one-half crops", and 3 percent "two-thirds crops".

Appendix Table 103. CORN: Normal yield per acre and production practices, somewhat poorly drained upland and bench soils, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	43	43
Pounds of N	97.9	54	55
Pounds of P_2O_5	84.8	29	34
Pounds of K_2O	84.8	28	33
Other practices (times over):			
Flat breaking, fall	2.1	.02	1.00
Flat breaking, spring	54.5	.55	1.00
Middle breaking, fall	1.4	.01	1.00
Middle breaking, spring	55.2	1.04	1.88
Discing, fall	2.8	.03	1.00
Discing, spring	97.2	2.28	2.35
Listing, spring	15.9	.19	1.21
Harrowing	95.9	1.48	1.55
Pre-emerge	2.1	.02	1.00
Post-emerge	3.4	.03	1.00
Hoeing and thinning	17.9	.18	1.00
Cultivation	100.0	3.13	3.13

[1] Based upon 145 observations. Farm drainage was indicated as 7 percent "poor", 70 percent "fair", and 23 percent "good". Rotation was indicated as 88 percent "all crops", 3 percent "one-fourth crops", 3 percent "one-half crops", and 6 percent "two-thirds crops".

Appendix Table 104. CORN: Normal yield per acre and production practices, all deep moderately well drained bottom soils, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	59	59
Pounds of N	97.6	70	71
Pounds of P_2O_5	62.8	23	36
Pounds of K_2O	62.8	23	36
Other practices (times over):			
Flat breaking, spring	64.7	.65	1.00
Middle breaking, fall	1.3	.01	1.00
Middle breaking, spring	41.0	.66	1.62
Discing, spring	95.2	2.51	2.63
Listing, spring	13.0	.14	1.08
Harrowing	96.0	1.40	1.45
Pre-emerge	12.6	.13	1.00
Post-emerge	17.4	.18	1.04
Hoeing and thinning	21.6	.23	1.07
Cultivation	100.0	2.94	2.94

1/ Based upon 546 observations. Farm drainage was indicated as 15 percent "poor", 51 percent "fair", and 34 percent "good". Rotation was indicated as 89 percent "all crops", 2 percent "one-fourth crops", 2 percent "one-half crops", and 7 percent "two-thirds crops".

Appendix Table 105. CORN: Normal yield per acre and production practices, all low wet soils, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	41	41
Pounds of N	97.4	55	56
Pounds of P_2O_5	97.4	34	35
Pounds of K_2O	97.4	33	34
Other practices (times over):			
Flat breaking, spring	64.1	.64	1.00
Middle breaking, fall	2.6	.03	1.00
Middle breaking, spring	35.9	.61	1.71
Discing, spring	94.9	2.43	2.56
Listing, spring	17.9	.20	1.14
Harrowing	100.0	1.76	1.76
Pre-emerge	10.3	.10	1.00
Post-emerge	7.7	.08	1.00
Hoeing and thinning	23.1	.26	1.11
Cultivation	100.0	3.00	3.00

1/ Based upon 39 observations. Farm drainage was indicated as 5 percent "poor", 74 percent "fair", and 21 percent "good". Rotation was indicated as 84 percent "all crops", 8 percent "one-half crops", and 8 percent "two-thirds crops".

Appendix Table 106. SOYBEANS: Normal yield per acre and production practices, all deep moderately well drained upland and bench soils, Mississippi Brown Loam Area, 1965.1/

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	23	23
Pounds of N	7.7	2	21
Pounds of P_2O_5	15.4	5	34
Pounds of K_2O	15.4	5	34
Other practices (times over):			
Flat breaking, fall	3.8	.04	1.00
Flat breaking, spring	61.5	.61	1.00
Middle breaking, fall	3.8	.04	1.00
Middle breaking, spring	26.9	.30	1.14
Discing, spring	96.2	2.69	2.80
Listing, spring	7.7	.08	1.00
Harrowing	100.0	1.46	1.46
Pre-emerge	23.1	.23	1.00
Cultivation	100.0	3.34	3.34

1/ Based upon 26 observations. Farm drainage was indicated as 69 percent "fair" and 31 percent "good". Rotation was indicated as 92 percent "all crops" and 8 percent "two-thirds crops".

Appendix Table 107. SOYBEANS: Normal yield per acre and production practices, all somewhat poorly drained upland and bench soils, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	24	24
Pounds of N	14.3	2	12
Pounds of P_2O_5	14.3	5	32
Pounds of K_2O	14.3	5	32
Other practices (times over):			
Flat breaking, spring	78.6	.79	1.00
Discing, spring	100.0	2.92	2.92
Listing, spring	7.1	.07	1.00
Harrowing	100.0	1.64	1.64
Pre-emerge	21.4	.21	1.00
Cultivation	100.0	3.14	3.14

1/ Based upon 14 observations. Farm drainage was indicated as 7 percent "poor", 64 percent "fair", and 29 percent "good". Rotation was indicated as 86 percent "all crops" and 14 percent "two-thirds crops".

Appendix Table 108. SOYBEANS: Normal yield per acre and production practices, all deep moderately well drained bottom soils, Mississippi Brown Loam Area, 1965.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	27	27
Pounds of N	3.5	1	15
Pounds of P_2O_5	19.3	8	40
Pounds of K_2O	19.3	7	38
Other practices (times over):			
Flat breaking, spring	50.9	.51	1.00
Middle breaking, spring	10.5	.12	1.16
Discing, fall	1.8	.07	4.00
Discing, spring	98.2	2.91	2.96
Listing, spring	7.0	.08	1.25
Harrowing	91.2	1.33	1.46
Pre-emerge	26.3	.26	1.00
Post-emerge	1.8	.02	1.00
Hoeing	7.0	.07	1.00
Cultivation	100.0	3.35	3.35

1/ Based upon 57 observations. Farm drainage was indicated as 9 percent "poor", 53 percent "fair", and 38 percent "good". Rotation was indicated as 86 percent "all crops", 2 percent "one-half crops", and 12 percent "two-thirds crops".

BULLETIN 705 APRIL, 1965

Angular Leaf Spot of Tung

(ALEURITES FORDII)

Mississippi State University

AGRICULTURAL EXPERIMENT STATION

Henry H. Leveck, Director

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COVER PICTURE: Severe incidence of angular leaf spot of tung in orchard of Lampton variety in Pearl River County, Mississippi, August 1964. Note combination of fruit spotting and severe defoliation of branches.

Mississippi Agricultural Experiment Station and U. S. Department of Agriculture cooperating.

ANGULAR LEAF SPOT OF TUNG

(Aleurites Fordii)

By T. van der Zwet, B. G. Sitton, S. Merrill, Jr., and W. W. Kilby[1]

The tung tree *(Aleurites fordii* Hemsl.), introduced in the United States in 1905 from China, was relatively free from diseases during its first 45 years in America. Minor diseases of the trunk, leaves, and fruit, including angular leaf spot, have been reported since 1925; but it was not until 1953 that angular leaf spot appeared in epiphytotic form in some orchards in Louisiana and Mississippi.

A complete review of the history of angular leaf spot, description of disease symptoms, life cycle of causal organism, conditions affecting disease development, economic importance, and a review of all experimental work towards control of the disease, are presented.

HISTORICAL REVIEW

Angular leaf spot of tung was first observed in 1908 by Miyake (13), a Japanese mycologist, while on a collection trip in Hunan Province, China. He found the causal organism in its imperfect stage and named it *Cercospora aleuritidis.* In 1940, Ou (16) discovered the perfect stage of the fungus in the dead tung leaves in the vicinity of Chungking, China, and named it *Mycosphaerella aleuritidis.* He reported the disease to be of economic importance.

Small commercial plantings of tung in the United States began about 1915 and extensive plantings were made in the 1920's in north central Florida, southern Mississippi and in other Southeastern States along the Gulf of Mexico. Leaf spot was first discovered in the United States in 1926 by West on trees of *A. fordii* near Gainesville, Florida, as reported by Martin (11). In America, as in China, the disease remained in a very mild form for many years. Plakidas (17) did not mention angular leaf spot in a publication on tung diseases in Louisiana in 1937, nor did Large (9,10), who published two lists of diseases of tung present in the United States. Weiss (33) was the first to include *M. aleuritidis* in a list of tung pathogens in the United States published in 1950. Wiehe (34) listed it a few years later in a complete bibliography of fungi and bacteria associated with all species of *Aleurites.*

A marked increase in the severity and prevalence of leaf spot was observed in Louisiana in 1953, and within the next 4 years, early defoliation of the trees occurred over the entire Tung Belt. Today, angular leaf spot is regarded as the most important disease of tung. In 1956 and 1958, the trees produced heavy crops of fruit, and the disease caused a reduction of 3 percentage units in the oil content of the tung fruit (18).

Angular leaf spot has also been reported from Brazil (14, 22, 32), Argentina (20), and former French Equatorial Africa (19). In 1954, a seemingly severe outbreak of the disease was reported from Japan (4, 21), where it is known as brown spot. A brief report on angular leaf spot in the United States was published by Bain (1). In 1961, van der Zwet (24) published a complete literature review of Mycosphaerella leaf spots occurring on all species of *Aleurites* throughout the world.

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SYMPTOMS OF ANGULAR LEAF SPOT

The first symptoms of angular leaf spot appear as pin-point spots on the lower leaf of 1-year-old volunteer seedlings about the time mature trees bloom. This lower leaf is then 2 to 3 weeks old. Other leaves appear at intervals of 1 to 4 days as the stem elongates and may be infected after rainfall releases ascospores from old leaves on the orchard floor. Thus, a gradient symptom pattern is produced on the seedling leaves. By early June, the spots on the oldest leaf have become typically angular in shape; the second leaf, which was infected later, will have a few smaller angular spots and several still smaller, nearly circular spots. Spots on the third leaf are mainly pin point in size, whereas the remaining younger leaves to the top of the plant appear free of spots (Fig. 1).

As the season advances, this symptom pattern continues, and the oldest leaf is the first to have large necrotic areas. Thus, the leaves will abscise in a similar succession. New seedlings, emerging from unharvested tung fruit of the previous season, do not appear until several weeks after bloom. First spots appear simultaneously on the two seed leaves which are the same age, while the new subsequent leaves follow a similar gradient symptom pattern as described for the 1-year-old seedlings.

First leaves on the orchard trees usually appear at blooming time or soon after. Some years, when erratic blooming occurs, leaves appear before bloom. The earliest disease symptoms are small spots, developing from ascospore infections, which appear on the earliest developed leaves between May 15 and June 1. In years of extremely dry spring weather, first spots may not show up until June 15. Since the shoot leaves are produced successively, the trees follow essentially a similar gradient symptom pattern as described for the young seedlings. The branches nearest to the ground and the oldest leaves on each branch will defoliate first. Late in the season, the last green leaves are present in the tops of the trees and at tips of branches.

Soon after the spots increase in size, they become angular in shape from being limited by small leaf veins. When the spots mature (6-12 mm. in diameter), the first crop of conidiospores is produced. Angular leaf spot can be distinguished from other leaf spots of tung by the grey tufts of considiospores, which can be observed with the naked eye by their silvery glitter in the sunlight. Wind-rain splash dispersal spreads the spores through the trees and slowly upward to leaves on higher branches. Since moisture persists longest along the main leaf veins and near the leaf tips, many spores germinate and cause infections in these areas (Fig. 2). The spots continue to enlarge, and in areas of extensive infections, the spots coalesce; this results in large areas of dead leaf tissue and eventual abscission of the leaf.

Tung fruit may also be infected and the first fruit spots appear at any time after July 1 (Fig. 3-a). As soon as many of the spots on the leaves become mature and produce an abundant crop of conidiospores, the number of fruit spots increases rapidly (b). Almost all spots appear on the lower half of the tung fruit, presumably due to the fact that conidiospores lodge along the hull when rainwater washes them down. Many spots have been observed near the apex of the fruit where most of the moisture persists longest (c). The fruit spots soon increase in size, coalesce, and cause large, black, slightly sunken lesions (d) on which the fungus fruits very abundantly. Severely infected fruit will drop prematurely as early as August 15.

Besides the leaf and fruit symptoms, angular leaf spot also occasionally causes dark brown to black, elliptic, slightly sunken lesions on stems, petioles, and

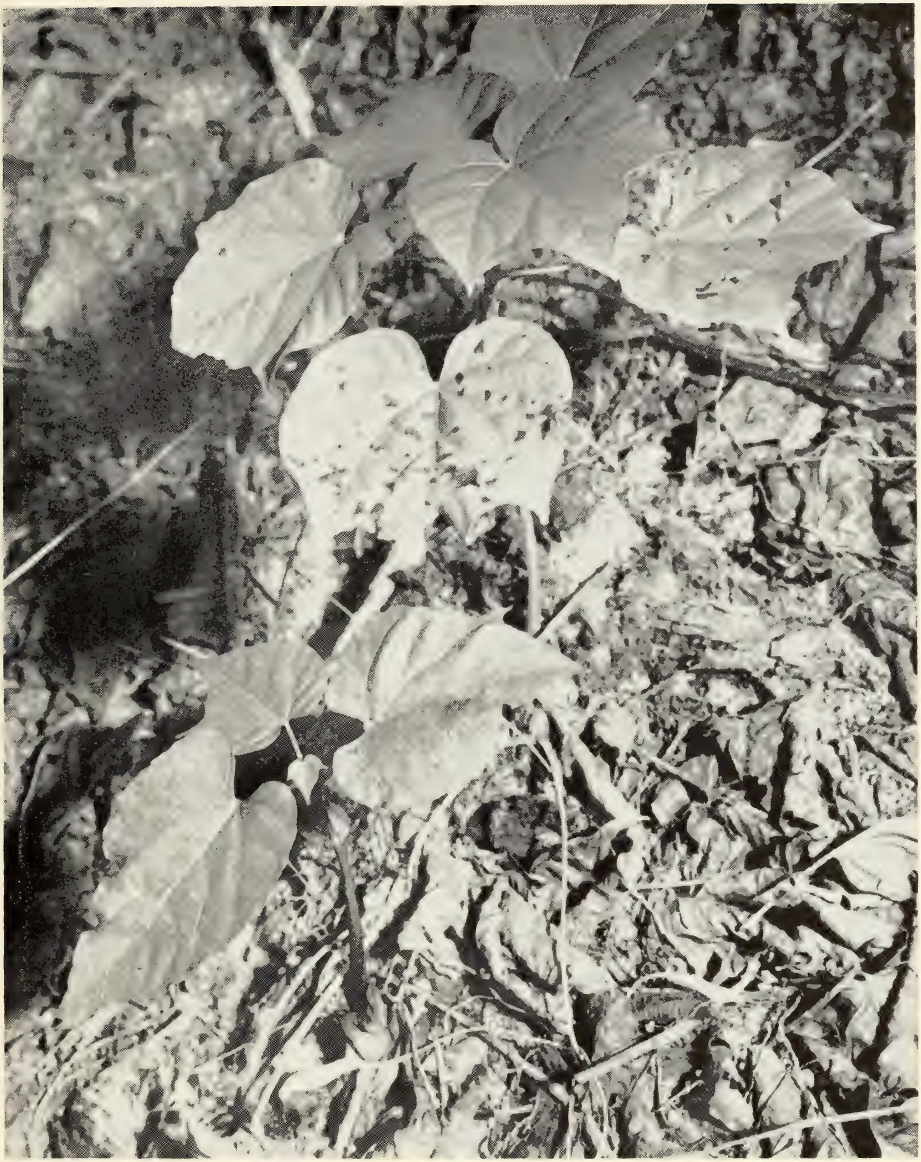

Figure 1. Gradient symptom pattern of young and old primary infections of angular leaf spot on the first 3 leaves of a 1-year-old volunteer seedling. New seedling with first seed leaves in the foreground. Old leaves on the ground were the source of ascospore inoculum.

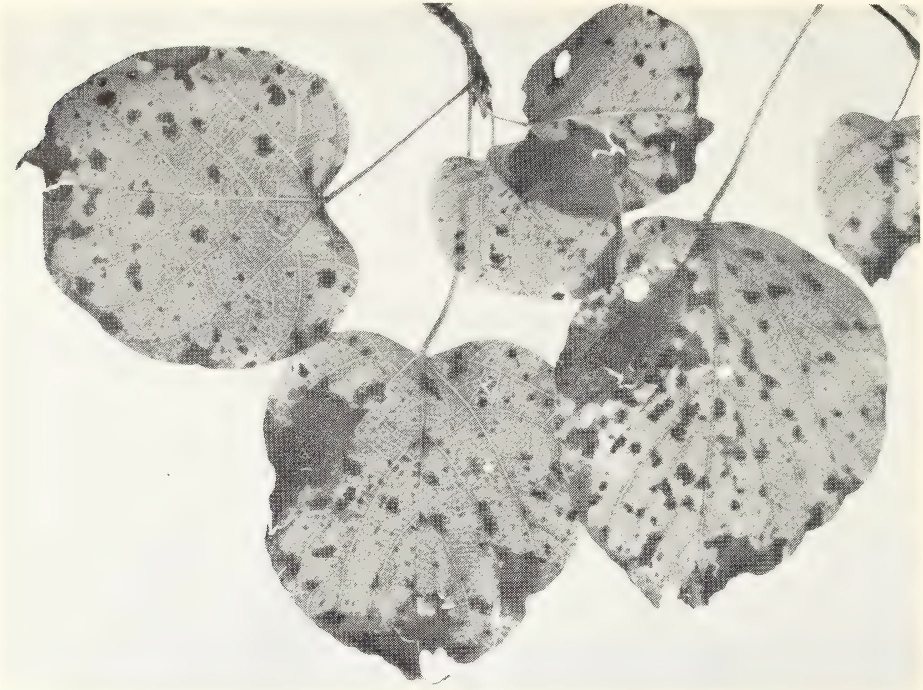

Figure 2. Advanced symptom of angular leaf spot with coalescence of spots and larger necrotic areas along some edges and main veins on leaves of orchard trees.

green twigs (Fig. 4). Since the green stems and twigs become brownish during the winter, the lesions are hard to find the following season.

LIFE CYCLE OF CAUSAL ORGANISM

The organism that causes angular leaf spot of tung is a fungus which has two distinct stages in its life history: one, the parasitic stage, ordinarily occurs on the leaves and fruit during the summer; the other, the saprophytic stage, develops in the dead leaves on the orchard floor during fall and winter. The first stage is also referred to as the imperfect, asexual, or summer-spore stage, while the other is called the perfect, sexual, or winter-spore stage. This complete life cycle became known in 1940 when Ou discovered the perfect stage (16). Since the primary infection in the spring is initiated by the ascospores from organs developed during the winter months, it seems logical to start the description of the life cycle with the period of leaf drop in the fall (Fig. 5).

The saprophytic development begins with the penetration of the fungus into the mesophyll area of the leaf. Here it forms a layer of hyphae on which the perithecia are later developed. Growth of the perithecia is made during the fall and winter months, and maturity is reached with the return of warm weather in the spring. Inside the perithecia, the fungus produces fruiting structures known as asci, which, in turn, contain the winter spores or ascospores. These are 2-celled, transparent spores, which measure 10 to 12 microns in length and about 3 microns in width (Fig. 6-A). The characteristics of this sexual fruiting structure and its ascospores give the fungus its technical name, *Mycosphaerella aleuritidis.*

Discharge of the ascospores takes place mainly during March and April when the leaves on the orchard floor become thoroughly wetted (27). The asci elongate very rapidly and discharge their ascospores through the opening of the perithecium a short distance into the air. Air currents then carry the spores to the newly developing tung leaves on volunteer seedlings and mature trees, where they cause infections. Some ascospores are discharged throughout the growing season but the primary infection period lasts mainly until June 1, when the secondary infection period begins (upper portion of Fig. 7).

Observations during the past five years have shown that ascospore infections are most numerous on leaves on the lower portion of the tree. On June 30, 1961, leaves on branches 2 to 6 feet above an uncultivated orchard floor had significantly more spots per leaf than did those 10 to 35 feet high. On July 14, 1964, 67% of the leaves on branches of Isabel seedling trees, 3 feet above the ground, were infected, as compared to 56% of the leaves at the 9 foot tree height and 30% of those at the 15 foot height (26). Also, the earliest leaves on the tree receive primary inoculum throughout the period of ascospore discharge. Leaves produced during June and July will escape most of the ascospore infections. On July 24, 1964, leaf spot counts were made on leaves of 100 shoots of the same trees, which had an average of 14 leaves per shoot. Of the oldest 6 leaves, 87% were infected and had 3.8 spots per leaf, as compared to 36% infected leaves with 0.7 spots per leaf, on the remaining 8 leaves.

Ascospores germinate rapidly in the presence of moisture, and the germ tubes infect the leaf. After 3 to 5 weeks, pinpoint spots become visible and soon increase in size. In these spots, the organism

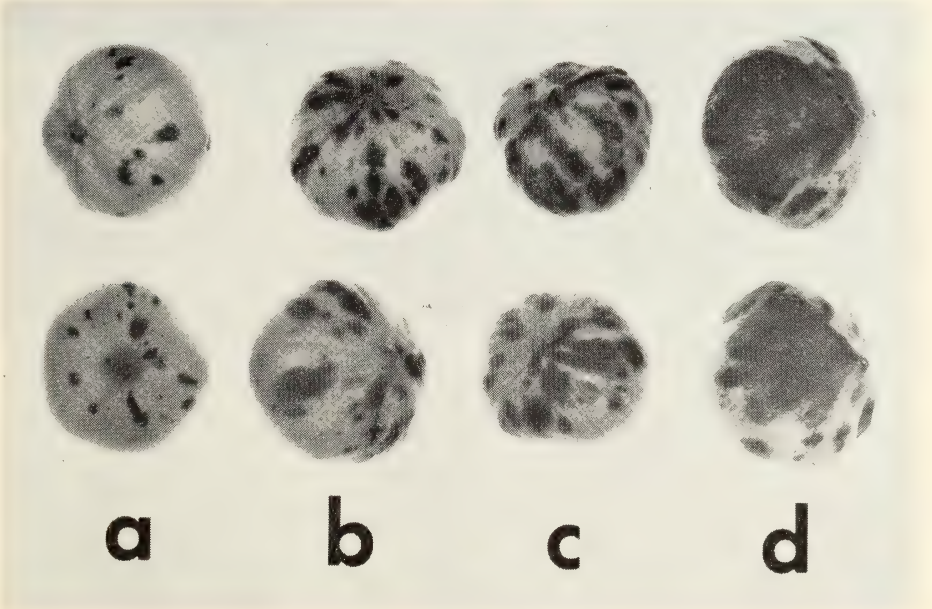

Figure 3. Fruit symptom of angular leaf spot on the green hulls of nearly mature fruits: a, first fruit spots; b, additional fruit spots following abundant sporulation of leaf spots; c, typical spotting around fruit apex; d, advance coalescence of fruit spots, resulting in black sunken lesions and rotting of the hull.

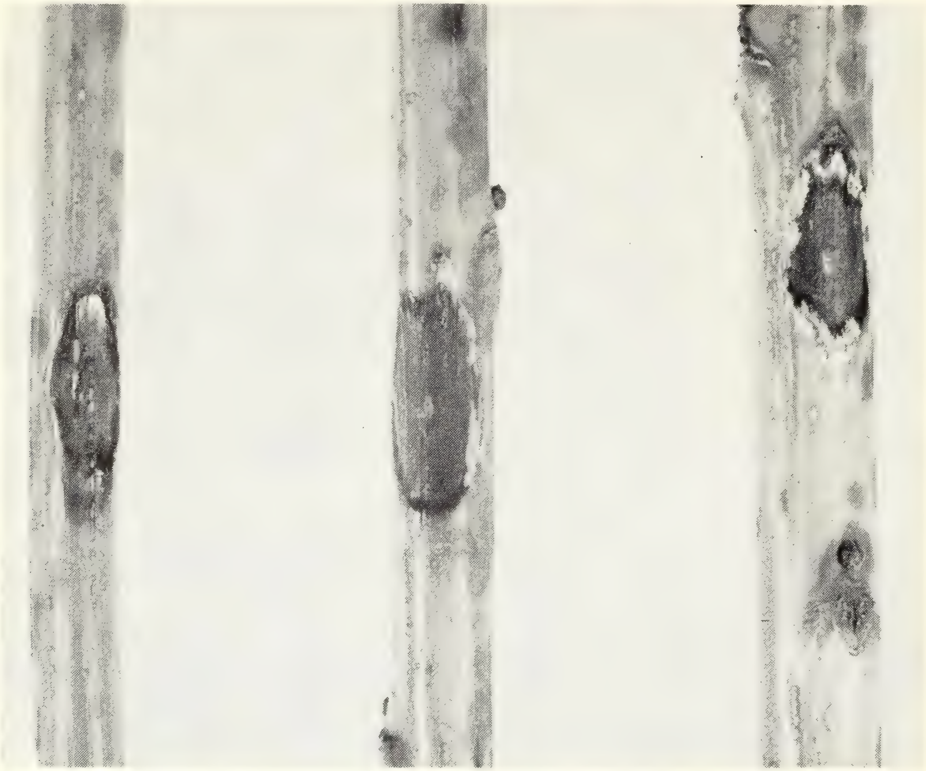

Figure 4. Black, sunken lesions on green stems and shoots of tung seedlings.

becomes parasitic. It produces tiny black structures called stromata, on which the fungus forms the summer spores, or conidiospores (conidia). These spores are produced vegetatively on conidiophores or spore carriers as early as June 1. Conidial production is abundant on both leaf sides. The conidia are long needlelike, subtransparent, slightly curved spores which measure 50 to 100 microns in length and about 4 microns in width (Fig. 6-B). The typical characteristics of this spore type and its fruiting body give the fungus its technical name, *Cercospora aleuritidis.*

Conidiospores are not produced until the leaf spots have enlarged considerably and become angular in shape. When the conidia mature, they are detached from their conidiophores by wind and rain splash action and are disseminated throughout the orchard. After settling on leaves, they germinate readily in the presence of moisture and cause new infections. Artificial inoculation of the dorsal sides of leaves of nursery seedlings with conidial suspensions, during late summer of 1964, revealed that the fungus required 10 days for incubation on young leaves; 14 days were needed for intermediate-aged leaves, and 18 days for old leaves (3). Spots on leaves inoculated on the ventral side were slower in appearance and required up to 21 days to appear on some plants, regardless of leaf age.

Observations made during the growing season of 1964, in an orchard of Isabel seedling trees, indicated that by June 15, 34% of the leaves on nearly 100 terminals had leaf spots; by August 6, 65%; and by September 26, 90%.

The fungus produces many conidiospores on both upper and lower leaf surfaces and very abundantly on lesions on the hulls of green fruit. This period of vegetative propagation or secondary infection continues throughout the remainder of the growing season until the leaves drop from the trees in the fall. Thus, the fungus returns to its saprophytic mode of life and completes its life cycle.

Some variations from the life cycle as outlined may occur. Black lesions are produced on the green fruit and have also been observed occasionally on water sprouts, stems, and leaf petioles of trees and seedlings (Fig. 3 and 4). Even though no perithecia have been observed on these plant parts, the few condiospores produced on these lesions on old stromata from the previous season may add to the inoculum for the primary infection.

Besides the conidial and ascigerous stages, also a spermatial spore stage has been observed on the leaves during fall and winter. These spermatia are transparent, rod-shaped spores, measuring 4 x 0.5 microns, and are produced inside a spermogonium. These spores may play a role in the sexual reproduction of the fungus to produce perithecia. How the spermatia function as one of the sexual elements in perithecial development is not perfectly understood.

CONDITIONS AFFECTING DISEASE DEVELOPMENT

The causal organism of angular leaf spot is classified as a weak parasite, which is most destructive when all conditions for its development are most favorable. These principal conditions are tree yield, variety of tung, cultivation, fertilization, and meteorological factors.

Tree Yield and Varieties. An important factor for a severe occurence of angular leaf spot is a heavy yield of fruit on the trees. The effect of a heavy yield on leaf-spot incidence may be caused in different ways: a large number of fruit per shoot will cause a low leaf: fruit ratio and, therefore, produce a strong demand for photosynthate for growth of leaves and fruit and subsequent synthesis of oil in the kernels; secondly, a heavy crop tends to weigh down the branches of a tree, resulting in a matting of the leaves and, therefore, interfering with air movements.

From Lampton trees near Cairo, Georgia, Neff[2] obtained the following preliminary data supporting these two ideas. In August 1961, branches were girdled to stop translocation of carbohydrates from the leaves. On October 3, leaves on girdled branches averaged 7 spots and were yellowish in color, indicating carbohydrate accumulation. Those on ungirdled branches were normal in appearance and averaged 84 spots per leaf. The spots, present on leaves on girdled branches at the time of girdling, probably grew in size, but few, if any, new spots appeared subsequent to girdling.

On September 22, 1961, all but 2 leaves on each of 29 bearing shoots were removed, establishing a leaf: fruit ratio of 0.7, and were compared with 2 leaves of similar age and size on undefoliated shoots having a ratio of 10.0. Neff found after 37 days, that leaf-spot incidence had increased by 157% on the leaves of the partially defoliated shoots as compared to 211% on those of the undefoliated shoots. Regardless of the number of fruit per shoot, removal of all but 2 leaves reduced leaf-spot incidence below that of leaves on undefoliated shoots. These observations indicate that the absence of most of the leaves may have caused less favorable conditions of light, humidity, and air movement for development of the leaf spot organism.

Differences in susceptibility to leaf spot and fruit spot have been noticed between seedling trees and between tung varieties.

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[2] Unpublished data. Annual Report, U. S. Field Laboratory for Tung Investigations, Cairo, Ga., 1962.

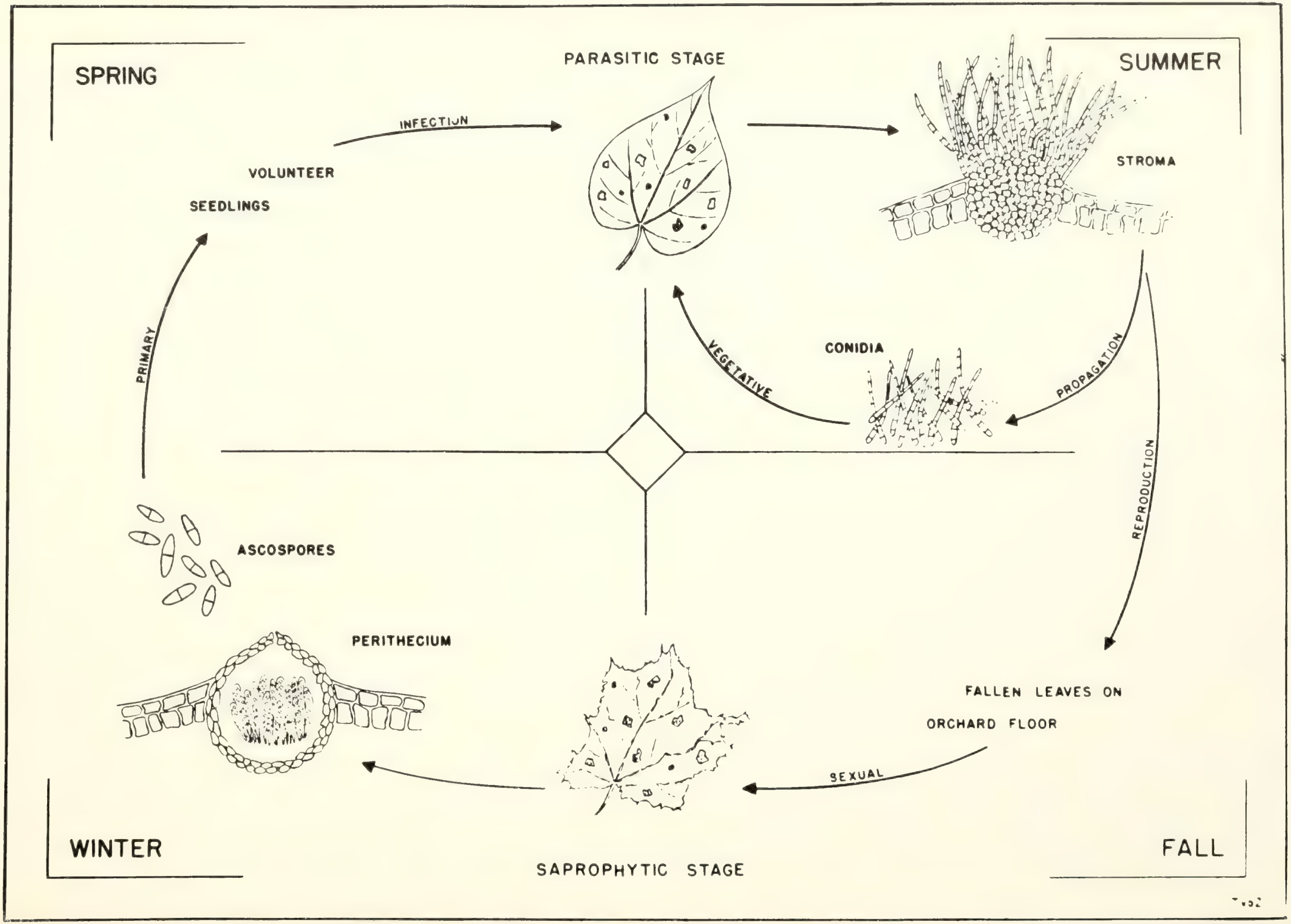
SPRING
PARASITIC STAGE
SUMMER
INFECTION
VOLUNTEER
SEEDLINGS
STROMA
PRIMARY
CONIDIA
VEGETATIVE
PROPAGATION
REPRODUCTION
ASCOSPORES
PERITHECIUM
FALLEN LEAVES ON
ORCHARD FLOOR
SEXUAL
WINTER
SAPROPHYTIC STAGE
FALL

Figure 5. Diagram of the life cycle of *Mycosphaerella aleuritidis*, the causal organism of angular leaf spot of tung

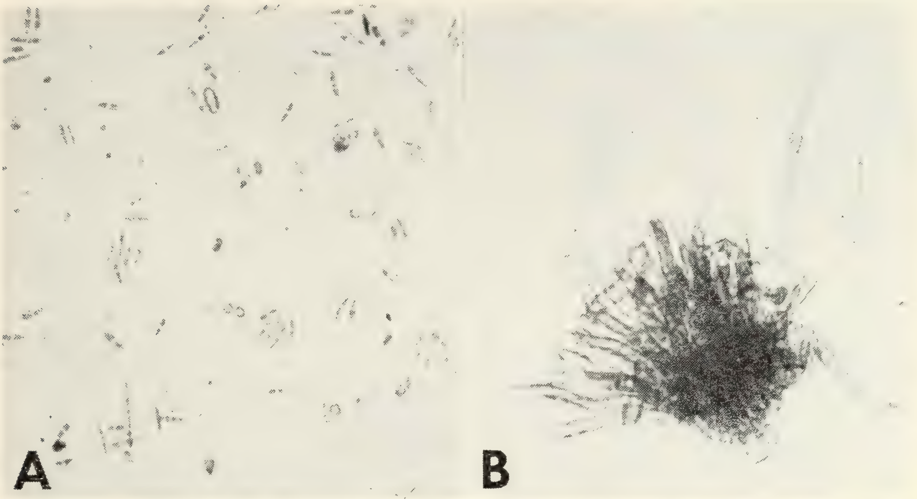

Figure 6. Photomicrographs of two spore types of the causal organism of angular leaf spot of tung: A, ascospores of M. aleuritidis; B, stroma and conidiospores of C. aleuritidis. (approx. 1500 x)

Seedling trees of five commercially grown tung varieties were scored in 1961 for leaf and fruit infection and early tree defoliation. Mean yields were recorded at five locations in Pearl River County, Mississippi, and oil determinations were made of samples of fruit from each varietal progeny and location (Table 1). At all locations, seedlings of Lampton (F-578) had the highest disease incidence rating, followed closely by Isabel (L-2); La Crosse (F-99), Gahl (L-51), and Folsom (L-47) had lighter disease ratings, which confirms earlier observations (12). In all varieties regardless of location, heavy bearing was accompanied by increased severity of leaf spot and reduction in oil content of the fruit.

On October 10, 1964, Draper and van der Zwet[3] scored clonal and seedling progenies in an experiment near Irvington, Alabama, for incidence of leaf and fruit spot. They found that trees of L-2, L-47, and L-51, had significantly less leaf spot than those of F-578. Unreleased selections, numbered F-554, L-46, and L-152, rated more resistant than the progenies listed above. At this same late date, a large portion of the fruit with extremely low fruit-spot incidence was still present on the trees of F-554, L-46, L-47, L-51 and L-152.

Cultivation and Fertilization. Cultural practices affect leaf-spot development mainly through turning under the dead leaves on the orchard floor in early spring before primary infection occurs. This subject is discussed in detail under control measures of angular leaf spot (see orchard sanitation).

Summer cultivation and proper fertilization are also important cultural practices for optimum healthy growth of the trees. In an experiment at Agricola, Mississippi, 9-year-old Lampton seedling trees, grown under each of four management procedures, were rated for angular leaf spot. Kilby and Sitton (5) reported that leaf-spot incidence on trees at the high nutritional level was significantly less than on trees at the low level. Greatest incidence

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[3] Unpublished data in the files of the U. S. Field Laboratory for Tung Investigations, Bogalusa, La., 1964

Table 1. Effect of tree yield on the incidence of angular leaf spot and on the oil content of the fruit of seedling trees of five commercially grown tung varieties. (Pearl River County, Miss., Fall 1961)

Tung seedling of	Disease incidence[1]			Average yield	Oil content[2] %
	Leaf infection	Tree defoliation	Fruit infection		
Lampton (F-578)	3—	1+	2+	Medium	21.4
Lampton	4+	3	4	Heavy	19.4
Lampton	3+	2—	3	Medium	22.2
Lampton	4	2—	3+	Heavy	21.3
Isabel (L-2)	3—	1+	1+	Light	21.0
Isabel	3	2	3+	Heavy	19.2
Isabel	2	1	2+	Heavy	19.7
Isabel	2+	1	2—	Medium	21.0
Isabel	2	1+	2	Medium	20.4
La Crosse (F-99)	2—	1	2—	Medium	19.3
La Crosse	2+	3—	2	Heavy	18.9
La Crosse	2—	1	2	Medium	21.5
La Crosse	2	1	2—	Light	21.6
La Crosse	2	1	2	Medium	21.6
Folsom (L-47)	1	1	1	Light	——
Folsom	2—	1	1+	Heavy	19.2
Folsom	4+	3+	4	Medium	22.1
Gahl (L-51)	1	1	1	Light	22.9
Gahl	2—	1+	1	Heavy	19.2
Gahl	3	2	3	Medium	19.2

[1] Disease rating: 1 = none; 2 = slight; 3 = moderate; 4 = severe; 5 = very severe.

[2] Percent oil in the whole fruit, equated to 15% moisture.

Table 2. Effect of low and high levels of fertilization with combinations of cover crops and cultivations on the incidence of angular leaf spot on 9-year-old Lampton seedling tung trees. (Agricola, Miss., October, 1960)[1]

Cultural treatments		Level of fertilizer		
Cover crop	Cultivation	Low	High	Average
		rating	rating	rating
Bahiagrass	once annually	3.5	2.9	3.2
Bahiagrass	none	3.5	2.8	3.2
Crimson clover	three annually	3.1	2.5	2.8
Crimson clover	once annually	3.3	2.6	2.9
Average		3.4	2.7	

F found for fertilizers, 71.32; F required at .001, 13.29.

Rating of general disease incidence: 1 = 25% of leaves spotted; 2 = 50% of leaves spotted; 3 = 75% of leaves spotted; 4 = nearly 100% of leaves spotted; 5 = same as 4 plus some defoliation; and 6 = same as 4 plus considerable defoliation.

of leaf spot was observed on trees at the low nutritional level on Bahiagrass, due in part to competition of the grass and the trees for soil moisture (Table 2). Similar effects have been observed every year throughout the Tung Belt in orchards grown in grass sod.

Meteorological Factors. The most important meteorological factor in the development of angular leaf spot is undoubtedly the twofold effect of rainfall: 1) directly, during the first half of the growing season, by causing ascospore discharge and making conditions favorable for primary infection; and 2) indirectly, during the second half of the growing season, when good moisture supply increases the vigor of the trees and their resistance to the disease.

The discharge of ascospores is strictly dependent upon the presence of moisture, particularly rainfall. The dead leaves must be thoroughly soaked before abundant discharge occurs. During a dry spring, large numbers of ascospores are matured and remain in the perithecia. Under these conditions a soaking rain will bring about a heavy discharge, and if wet weather continues, a severe infection results. On the other hand, frequent light rains may result in a number of minor spore discharges with an almost continuous period of primary infections.

Research on trapping ascospores of *M. aleuritidis* during the past five years has indicated that: 1) ascospores are discharged mainly during the first two months of the growing season, usually March and April; 2) highest numbers of ascospores are discharged during and up to 24 hours after rainfall, with significantly higher numbers during the first 6 hours of a 24-hour period; and 3) ascospores travel in horizontally and vertically upward-moving air currents for several days after a rain (27, 30). Heavy dews will release some ascospores.

Germination of ascospores occurs only in the presence of sufficient moisture to keep the spores wet over a period of time. The period from infection to the first evidence of the disease is the incubation period. In the case of angular leaf spot this period will range from 30 to 40 days during dry, cool spring weather with maximum temperatures ranging from 60 to 80° F., and from 20 to 30 days during humid, warm weather in early summer with maximum temperatures from 80 to 90° F.

Observations during the summer months have indicated that rains are essential for the dissemination of the conidiospores to cause secondary infections. Especially in stormy weather, strong winds are probably very favorable for wind-splash dispersal of conidiospores and consequently favor rapid increase in leaf and fruit infections. When rains occur at the time that conidia are being produced abundantly on the leaves, fruit spots become more numerous. The process of germination and infection for conidiospores is again dependent upon sufficient moisture. In the laboratory at a room temperature of 80° F., conidiospores germinated in water within 4 hours. Nearly all conidia on a glass slide germinated within 16 hours, at which time about half of the individual spore cells showed germ tubes.

The indirect effect of rainfall on the development of angular leaf spot plays a role mainly during the latter part of the growing season. It has been observed for several years that small leaf spots will not increase in size during seasons with continuous rainfall. This seems to be true especially for the period immediately following primary infection (May-June), as well as during the latter part of the secondary infection period (Aug.-Sept.). An occasional shower will be advantageous to spore dissemination, but continuous, heavy rainfall throughout the summer keeps the trees growing vigorously and seems to keep the leaves resistant to the disease.

The main effect of temperature on angular leaf spot results from early high spring temperatures that cause early leaf development and ascospore discharge, thus lengthening the period of primary infection as well as the entire growing season. There is no indication that temperature is of much influence on the development of the disease during the summer.

Complete meteorological records in regard to angular leaf spot have been collected at the Experimental Tung Farm near Poplarville, Mississippi, every year

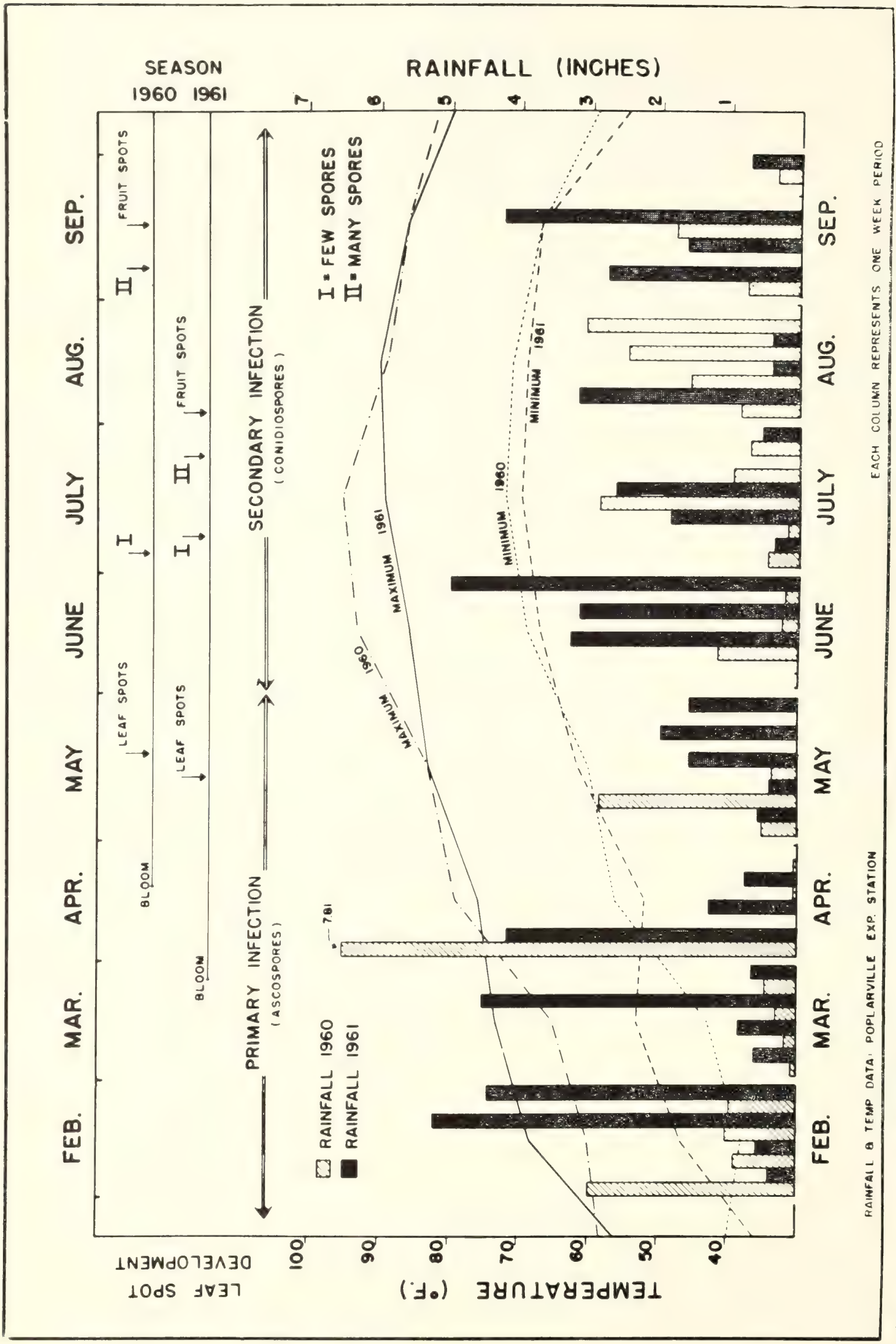

Figure 7. Effect of rainfall and temperature on the development of angular leaf spot of tung in Pearl River County, Mississippi, during the growing seasons of 1960 and 1961.

since 1960. Van der Zwet and Kilby (28) published a detailed account of the factors that affected the development of leaf spot during 1960 and 1961. A rather light crop was produced in 1960 but a heavy crop in 1961. In addition, warm temperature and high rainfall during spring accelerated disease development in 1961. The average minimum and maximum temperatures for February and March were 8 degrees higher in 1961 than in 1960. More, well-distributed rains fell during March and April 1961, than during the same period in 1960 (Fig. 7).

In both years, first leaf spots were observed by the middle of May and light conidiospore production (I) by early July, but the number of leaf spots was much more numerous in 1961 than in 1960. This fact, combined with much rainfall during May and June of 1961, resulted in abundant conidiospore production (II) by the end of July and many fruit spots on the heavy crop in early August. By the end of the growing season, only mild leaf-spot incidence was observed in 1960, whereas in 1961 the trees suffered early defoliation and a slight reduction in the oil content of the fruit in several orchards.

A comparison of weather records and seasonal conditions has been made for the seasons 1955 through 1964. During the light crop years of 1955, 1957, 1960, 1962, and 1963, there was a shortage of rainfall during the primary infection months in the spring. Rainfall was light during the early summers, but heavy towards the end of the growing seasons of all these years except 1962, which was rather dry all summer. All these years are considered as mild leaf spot years in which there was no material loss of oil.

The rather heavy crop years of 1956, 1958, 1959, 1961, and 1964, however, had favorable rainfall during the spring months, conducive to optimum primary infection. Considerable rainfall also occurred during early summer but only a few rains fell towards the end of of the growing seasons. During 1956 and 1958, the combined effects of heavy crops with these weather conditions was conducive to the development of severe leaf-spot incidence. A severe loss of the oil occurred in a spray experiment as reported below. During 1959, 1961, and 1964, the trees carried medium to heavy crops and incidence of leaf spot was moderately severe. Reductions in the oil content were reported from several locations throughout the Tung Belt.

The most severe incidence of angular leaf spot can be expected with the occurrence of the following favoring conditions:

1. A heavy crop of fruit on the trees.
2. The presence of old leaves on the orchard floor.
3. High temperature in early spring.
4. Frequent, heavy rains during March and April.
5. Frequent, light rains during June and July.
6. Limited rainful during August and September.

ECONOMIC IMPORTANCE

No disease of great economic consequence had occurred in tung orchards in the United States before 1953, when angular leaf spot became severe. To determine the effect of the disease on yield and oil content of the fruit, Bordeaux mixture inclusive, to 16 plots of Lampton seedling sprays were applied from 1956 to 1960, trees. These were compared with an equal number of plots of unsprayed trees. Although it was recognized that spraying with Bordeaux would never be economically feasible in tung orchards, no other means of keeping the trees free of the disease was known. Potter and Crane (18) reported in 1957 that the sprayed trees showed practically no defoliation in August, whereas half of all the leaves had fallen from the unsprayed trees.

For the first 4 years premature fruit drop was severe from the unsprayed trees

Table 3. Effect of angular leaf spot on percentage premature fruit drop and total oil content of the fruit of 6- to 10-year-old Lampton seedling tung trees sprayed for 5 years with Bordeaux mixture.

Year	% Premature yield[1]				% Oil in total yield[1]		
	Date	Ck	Bord.	F[2]	Ck	Bord.	F[2]
1956	9/11	22	1	216.26	16.5	19.8	42.30
1957	9/17	39	16	53.00	22.4	21.7	4.49
1958	9/3	47	22	56.33	16.0	19.0	18.33
1959	9/22	33	10	126.99	22.9	23.0	....
1960	10/3	16	14	.....	22 6	22.1	....
			Five year accumulation (1956-1960)				
Treatments		31	11	128.66	20.0	21.0	13.74
Years				55.02			106.98
Treat. x years				13.88			15.19

[1] Percent oil in whole fruit, equated to 15% moisture.

[2] F required (Treatments) at .05, 4.54; .01 8.68; .001, 16.59.
(Years, Treat. x years) at .05, 2.52; .01, 3.65; .001, 5.31.
F values less than one are omitted.

and significantly greater than from the sprayed trees (Table 3). In 1956 and 1958, the fruit from the Bordeaux-sprayed plots averaged 19.9 and those from the unsprayed plots 16.6 percent oil. The difference was highly significant and amounted to 56.8 pounds of recoverable oil per ton of whole fruit, valued at $13.63 at the 1964 prevailing price of 24 cents per pound of oil. This resulted in a loss of nearly 25 percent to the growers. However, there was no significant reduction in the oil content of the fruit in the other three years, because the conditions were less favorable for the development of the disease.

Combining the data of the years 1956 through 1960, the percentage premature fruit drop was significantly higher (20%) in the unsprayed plots than in the plots sprayed with Bordeaux mixture. The overall percentage oil in the whole fruit was 1.0 percent lower in the unsprayed plots. This difference would amount to a loss of $4.13 per ton of whole fruit on the 1964 tung oil market. This period includes two severe leaf spot years (1956 and 1958), two mild years (1957 and 1960), and one moderately severe year (1959).

Studies conducted in 1961 and 1964 showed that the oil content of severely infected fruit was significantly lower than that of clean fruit collected from the same tree. The average oil content of fruit picked from Lampton and Isabel seedling trees on September 21 and October 15, 1961, was about 2 percentage units lower in the infected fruit than in the uninfected fruit. Severely infected fruit collected from the same varieties in late August and late September, 1964, had an average of 4 percentage units less oil than the perfectly clean fruit collected from the same trees at the same time. This phase of the leaf spot problem may be an important factor in the reduction of the oil content of the fruit by the disease.

CONTROL MEASURES

Ever since 1953, when angular leaf spot appeared to become of economic importance to the tung industry, it became apparent that control measures would probably someday be necessary. Based on knowledge that the causal organism of angular leaf spot overwinters in the dead tung leaves on the orchard floor, early disease control experiments were focused on orchard sanitation. In succeeding years, attempts to control leaf spot through summer spraying of the trees were investigated, while in the meantime a long-range breeding program was initated for the development of tung varieties resistant to leaf spot.

Orchard Sanitation. One of the earliest leaf spot observations was that volunteer seedlings growing under the mature trees were more severely infected than those between the tree rows where the old leaves had been destroyed by cultivation (23). This observation, combined with the fact that the primary infection is due mainly to ascospores released from the dead leaves under the trees, pointed toward a possible practical means of leaf spot control through early destruction of these leaves by thorough cultivation.

Greenhouse-grown seedlings were planted after the last cultivation in plots with about 30 trees each, cultivated in December, January, February, or March, 1961, and in an uncultivated check plot. Leaf-spot incidence on the plants was significantly lower at any of the cultivation dates than in the uncultivated plot. The plants in the plots cultivated in February or March showed less infection than those in plots cultivated in December or January. The difference associated with times of cultivation probably is due to more effective covering of the dead leaves in late February or March, since they become brittle and smaller in size.

During 1961 and 1962, several exploratory sanitation plots results in the delay of leaf spot development. Nearly 100 percent of the leaves on volunteer seedlings were infected in early August of 1961 in both a cultivated and uncultivated orchard, but there were only 27 spots per infected leaf in the clean orchard as compared with 161 in the uncultivated orchard (31). On July 10, 1962, leaves on orchard trees in plots cultivated in early spring had only 27 percent as many spots as those on trees in uncultivated plots (29). By mid-August, this percentage had reached 50. Increase of disease incidence was greater in the cultivated plots than in the check plots. However, weather was unfavorable for leaf spot development during 1962.

In 1963, two 9-acre areas in each of 2 orchards were cultivated in February and similar areas left uncultivated. In each orchard, the ground in one cultivated area was sprayed with 200 gallons per acre of a solution of 0.5% Sodium Dinitro-Ortho-Cresylate (SDOC) in water just before earliest ascospore discharge. Even though the percentage of diseased leaves on volunteer seedlings on June 1 was only slightly lower in the cultivated areas than in the check areas, the percentage of leaves dropped due to severe infection and the number of leaf spots per seedling was considerably lower in the cultivated and sprayed areas (Table 4). On July 1, about 40% as many spots were present on leaves of previous season's terminals in the uncultivated but unsprayed areas as in the check areas. The SDOC ground spray did not increase the effectiveness of cultivation under the weather conditions unfavorable for primary infection during the spring of 1963.

In 1964, four large areas were used to compare the effects, on leaf-spot incidence, of no cultivation, early cultivation, early cultivation plus SDOC ground spray along a 10 foot swath on each side of the tree row, and early cultivation plus SDOC ground spray over the entire orchard floor. To limit the inclusion of disease incidence, due to infection from outside the treated area, records were made on 100 trees in the center of each area. On June 2, the lowest incidence of leaf spot was measured on trees in the areas that were cultivated early and received the ground spray (Table 5). By July 20, differences in percentage of dis-

Table 4. Effect of orchard sanitation on the primary infection and development of angular leaf spot on one-year-old volunteer tung seedling (June 1) and tree terminals (July 1) of Isabel seedling orchard trees (Spring 1963).

Location Treatment	Volunteer Seedlings			Tree Terminals	
	Diseased leaves	Dropped leaves	Spots/ seedl.	Diseased leaves	Spots/ term.
	%	No.	%	%	No.
White Sand, Miss.					
Uncultivated	53	15	212	35	19
Early cultivation	51	1	133	19	8
Early cultiv. + SDOC[1]	42	0	50	13	5
Bush, La.					
Uncultivated	77	15	383	79	71
Early cultivation	64	1	257	52	29
Early cultiv. + SDOC[1]	59	1	166	59	37

[1] SDOC = Sodium Dinitro-Ortho-Cresylate.

eased leaves were non-significant. The number of spots per leaf, however, was significantly higher in the uncultivated area than in any of the sanitated areas. The difference persisted as late as September 15. Even though no significant differences occurred in the oil content of the fruit between the treatments, there was a progressive increase from the uncultivated area to the most sanitated area, which was in reverse order of the incidence of leaf spot. Severely infected fruit, collected from the trees in the uncultivated area on September 25, had an average of 4 percentage units less oil than clean fruit collected from the same trees at the same time. Undoubtedly, the lower oil content in the fruit from the uncultivated area was due to the combined effect of severe fruit spot and leaf spot.

The evidence accumulated on orchard sanitation during the past 5 years indicates that: 1) early thorough cultivation reduces initial infection of the trees and delays development and build-up of leaf spot until late in the season; 2) early cultivation, followed by a ground spray of SDOC, seems to further reduce initial infection; 3) cultivation should be completed during February or before release of the first ascospores from the leaves on the orchard floor, which occurs as early as March 1; and 4) orchard sanitation should be done as thoroughly as possible, preferably with an off-set or wide tandem disk. Figure 8 shows a perfect example of a clean cultivated orchard. To be most effective, this early cultivation must cover all orchards in a given location.

The ultimate test of orchard sanitation as an effective control measure for angular leaf spot must await the occurrence of an epidemic year for the disease. However, early cultivation, done annually and on a wide scale, should progressively reduce the inoculum to the point that, even in years when conditions are optimum for disease development, leaf spot may not become severe early enough to cause a reduction in the oil content of the fruit.

Early spring cultivation is also of extreme importance to protect the trees against the often devastating hazard of spring frosts. Clean cultivation disposes of most of the trash and leaves a clean firm orchard floor. In combination with regular summer cultivations and proper fertilization, these cultural practices are the key towards optimum tung production. A complete discussion of the effects of early cultivation on economic production, leaf-spot reduction, and spring frost protection, including pictures of recommended farm equipment, was published recently (6).

Summer Spraying. Since high-volume Bordeaux spraying is not economically feasible in tung orchards, new summer spray trials were initiated in 1959 through the use of low-volume mists of petroleum oil, applied by knapsack sprayer, mist blower, and airplane. Kilby et al. (7) found that oil could be safely applied to the tung foliage at rates of 2 and 4 gallons per acre but that oil fortified with copper caused a chlorosis of the leaves.

During 1960 and 1961, additional experimentation indicated that: 1) oil applied soon after bloom at intervals of 2 or 3 weeks for periods of 4 to 6 months resulted in significantly less leaf-spot incidence than when applied for 0 to 2 months; 2) oil or Bordeaux mixture, applied in August, only slightly retarded further spread of the disease; 3) oil application by airplane with regular spray nozzles or micronair equipment seemed promising; and 4) oil fortified with organic fungicides did not reduce the disease incidence significantly below that obtained with oil alone (8, 31). It has to be remembered, however, that all above observations were made in mild to moderately severe leaf spot seasons.

Sprays applied by airplane will generally cover only the upper surfaces of tung leaves. Ground equipment could cover both leaf surfaces depending upon method of application. To study the relative effectiveness of leaf coverage, basic research on the etiology of angular leaf spot has revealed recently that the dorsal side of a tung leaf is much more susceptible to infection than the ventral side. Van der Zwet (25) reported that petroleum oil applied to the ventral side, at the same time that conidiospores were applied to the dorsal leaf side of young seedlings, reduced the amount of infection 40 percent. Satisfactory protection was also obtained with oil applied to the dorsal leaf side before conidial inoculation or within 4 days afterward. During the growing season of 1964, oil was also applied to either side of leaves on Isabel seedling trees in the orchard. By the middle of July, 50% of the leaves sprayed on the ventral side were infected versus only 35% of those sprayed on the dorsal side (26). On October 1, these percentages had reached 86 and 69, with percentages of leaf area infected of 3.0 and 1.8,

Table 5. Effect of orchard sanitation on the development of angular leaf spot and on the oil content of the fruit of local seedling orchard trees (Spring 1964).

Treatment	Leaf spot incidence[1]					
	Diseased leaves June 2	Diseased leaves July 20	Spots/leaf June 2	Spots/leaf July 20	Severity[2] Sept. 15	Oil[3] content
	%	%	No.	No.	rating	%
Uncultivated	53 a	61	2.9 a	4.3 a	2.5 a	20.3
Early cultivation	51 a	58	2.0 b	2.7 b	2.1 b	20.8
Early cultiv. + SDOC[4]	34 b	54	1.0 c	2.6 b	1.9 b	21.0
Early cultiv. + SDOC[5]	38 b	57	0.8 c	2.3 b	2.0 b	21.7

[1] Averages followed by any letter in common are not significantly different at the .05 level of probability.

[2] Rating of general disease incidence: 1 = 25% of leaves spotted, to 6 = nearly 100% of leaves spotted plus considerable defoliation.

[3] Percent oil in the fruit, equated to 15% moisture.

[4] Sodium Dinitro-Ortho-Cresylate along a 10 foot swath on each side of tree row.

[5] Sodium Dinitro-Ortho-Cresylate over entire orchard floor.

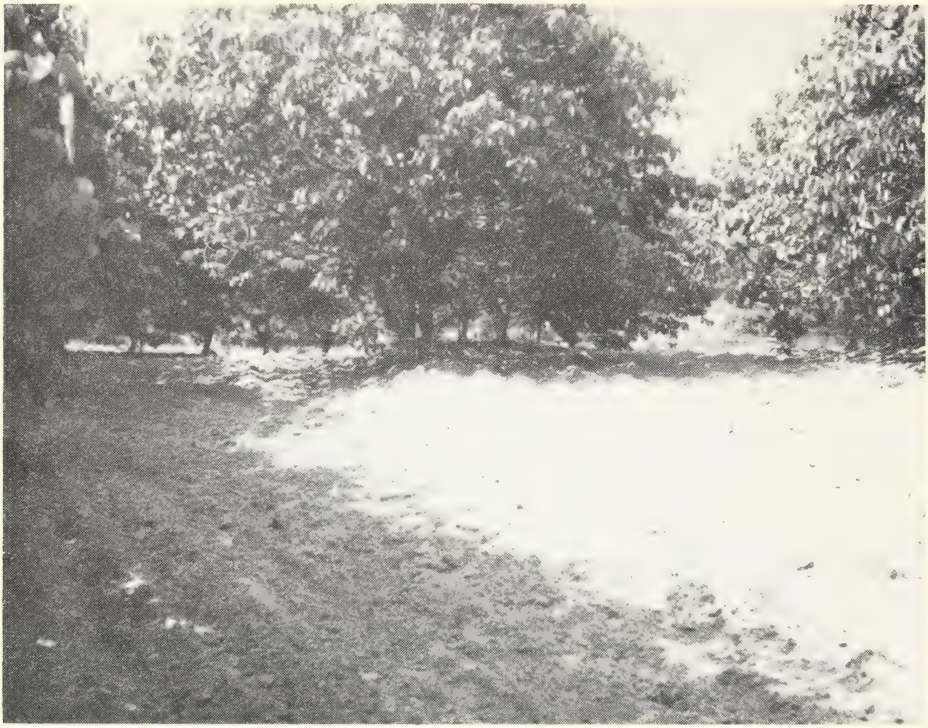

Figure 8. Proper orchard sanitation through early spring cultivation to reduce primary infection and subsequent severe development of angular leaf spot.

respectively. Of the unsprayed check leaves 90% were infected, with 5% of the leaf area involved.

This basic infomation should aid the formulation of most effective and efficient control measures whenever these may become necessary. The cost of spraying every year as an insurance against loss of oil would be unjustified. Recent experimentation has also indicated that, to be most effective, spraying should begin soon after bloom, to protect the foliage against primary infection. However, it is difficult to predict in early spring how severe angular leaf spot will become, and therefore, whether spray measures will be needed for that season. Therefore, the only practical control measure known today is a regular program of early and clean cultivation of the orchard, combined with proper, annual fertilization of the trees as currently recommended.

Resistant Varieties. As soon as angular leaf spot became severe throughout the entire Tung Belt, selection for disease resistance was included in the tung-breeding program. In 1959, Merrill et al. (12) reported that trees in the original seedling orchards showed considerable variation in susceptibility to leaf spot. Disease ratings made over a period of 5 years of clonal trees and of seedling progenies indicated that the Lampton variety (F-578) and its seedling progenies were the most susceptible of all tung varieties officially released by the U. S. Department of Agriculture (2, 15). Other susceptible varieties were Isabel (L-2) and La Crosse (F-99). Resistant varieties in increasing order were Gahl (L-51), Folsom (L-47), and Lamont (F-542). The ranking of these varieties has not been changed by current observations. Other trees with a high degree of leaf-spot resistance were discovered throughout the Tung Belt and were assigned numbers of F-554, G-37, L-46, L-301, M-67, M-142, and M-216.

In preliminary inoculation experiments at State College, Mississippi, Bain (1) found that seedling inoculation produced various leaf spot symptoms ranging from only flecks on some plants to regular spots on others. Budded plants showed a more uniform development of leaf spots. Recently, Draper and van der Zwet (3) studied the influence of age and side of tung leaves on the susceptibilty to angular leaf spot. They found that young and intermediate-aged leaves had significantly more spots per unit leaf area than old leaves, when inoculated with conidial suspensions. The dorsal side was found to be more susceptible than the ventral side of leaves of all ages. A program of hybridization and annual inoculation of progenies and new selections is currently under way and may someday produce a desirable tung variety, highly resistant to angular leaf spot.

SUMMARY

Angular leaf spot of tung *(Aleurites fordii* Hemsl.) was first observed in the United States in 1926 but did not become of economic consequence until 1953. Today, it is the most serious disease of this tree. The causal organism has a saprophytic winter stage (*Mycosphaerella aleuritidis* Ou) from which ascospores are produced that cause the primary infection in the spring; and a parasitic summer stage (*Cercospora aleuritidis* Miyake) which produces conidiospores that cause the secondary infection throughout the remainder of the growing season.

First symptoms of the disease are pinpoint spots on the lower leaves of volunteer seedlings, and, a few weeks after bloom, on leaves of orchard trees. These spots soon develop into the typical, angular spots, on which the fungus produces conidiospores abundantly on both leaf sides. Other symptoms of the disease are black, sunken lesions on the green fruit and on green shoots, water-sprouts, and petioles. Fruit lesions can cause a considerable reduction in the oil content of the kernels.

The fungus, a weak parasite, is very dependent upon weak host conditions and on meteorological factors optimum for disease development. The presence of a large crop of fruit on the trees, particularly on the more susceptible tung varieties, favors development of the disease. Proper annual fertilization and cultivation keep the trees in a high state of vigor to provide maximum resistance.

Spring rainfall is conducive to primary infection and summer rainfall to secondary infection. Continuous heavy rainfall during late summer promotes vigorous tree growth which resists disease development. Under adverse conditions, angular leaf spot can reduce the oil content of the fruit by as much as 3 percentage units.

During mild to medium leaf spot years, orchard sanitation through early spring cultivation will reduce the ascospore inoculum and delay disease development considerably. Experimental spraying during the summer has shown that Bordeaux mixture controls the disease satisfactorily in severe leaf spot years. Low-volume oil mists, with or without the addition of organic fungicides, applied by knapsack sprayer, mist blower, or airplane have indicated satisfactory control of leaf spot during mild disease years. Spraying is not economically feasible. No commercial spraying against angular leaf spot of tung is practiced in the United States. Tung trees show considerable variation in leaf spot resistance and a long range breeding project is currently under way for the development of resistant varieties.

RECOMMENDATIONS TO REDUCE THE INCIDENCE OF ANGULAR LEAF SPOT OF TUNG

1. Thorough clean orchard cultivation during February, or up to two weeks before bloom, to turn under the dead leaves and thereby reduce the amount of primary inoculum.
2. Proper annual fertilization prior to bloom, for maximum healthy growth of the trees.
3. Regular clean cultivation during early summer, or up to July 1, for healthy tree growth and the elimination of weeds and grasses.
4. Thorough annual spraying of the tree rows with a herbicide between May 15 and July 15, to destroy briars, weeds, and volunteer tung seedlings, and thereby prevent the accumulation of dead leaves during the winter.

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BULLETIN 706 MAY 1965

Channels And Costs Of Moving Cotton From Farms To Mills

Yazoo-Mississippi Delta

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CHANNELS AND COSTS OF MOVING COTTON FROM FARMS TO MILLS, MISSISSIPPI DELTA

By CHESTER M. WELLS, JR.

Availability of foreign-grown cotton and man-made fibers in adequate amounts of acceptable quality at relatively favorable prices has resulted in a serious decline in the relative position of United States cotton in domestic and world fiber markets. Current trends indicate that cotton produced in the United States will face increased competition from these fibers in the future. Lower costs of production and marketing must be realized if the domestic cotton industry is to survive this competition.

Industry leaders are advocating a crash research program to reduce production costs. The results expected are cost reductions large enough to make cotton competitive in price with other fibers.

Possibilities for reducing costs in marketing are more limited than are those envisaged in production. Even so, the necessity for improving the competitive position of cotton justifies an appraisal of these limited possibilities.

The purpose of this study was to investigate the potential for reducing marketing charges within the framework of the existing marketing system.

Specific objectives of the study were:

1. To determine changes in the marketing system and in channels of distribution of cotton since 1949-50.

2. To determine changes in marketing charges since 1949-50.

3. To estimate the potential for reducing marketing charges in those phases of marketing over which producers may exercise some control.

Method of Study

Channels of distribution of cotton in the 1949-50 season and in the 1960-61 season were determined by surveys of cotton marketing firms in the eleven Delta counties (Tunica, Coahoma, Quitman, Bolivar, Sunflower, Leflore, Washington, Humphreys, Sharkey, Issaquena, and Tallahatchie). Data for 1949-50 were from a sample of firms. Data for 1960-61 were from all known firms except country buyers (Table 1).

Few firms limited their business to any one type of activity. Most found it necessary or to their advantage to operate in several ways. Firms were classified on the basis of the type of operation that constituted the major part of their business. Data for each firm were reported separately for each type of operation in which the firm was engaged.

The following classification of firms was used:

1. **Factors.** These firms do not take title to cotton but sell for producers and other types of handlers and receive a brokerage fee for this service.

2. **Country Buyers.**[1] These buyers purchase cotton from producers and other types of handlers and sell to other local market firms or to firms in other markets.

3. **Country Shippers.** These are full-service merchandising firms that purchase uncompressed[2] bales in mixed lots at widely scattered locations and deliver them to specific locations (domestic or foreign mills) in even-running lots of compressed bales.

(4.) **Salary Buyers.** These buyers pur-

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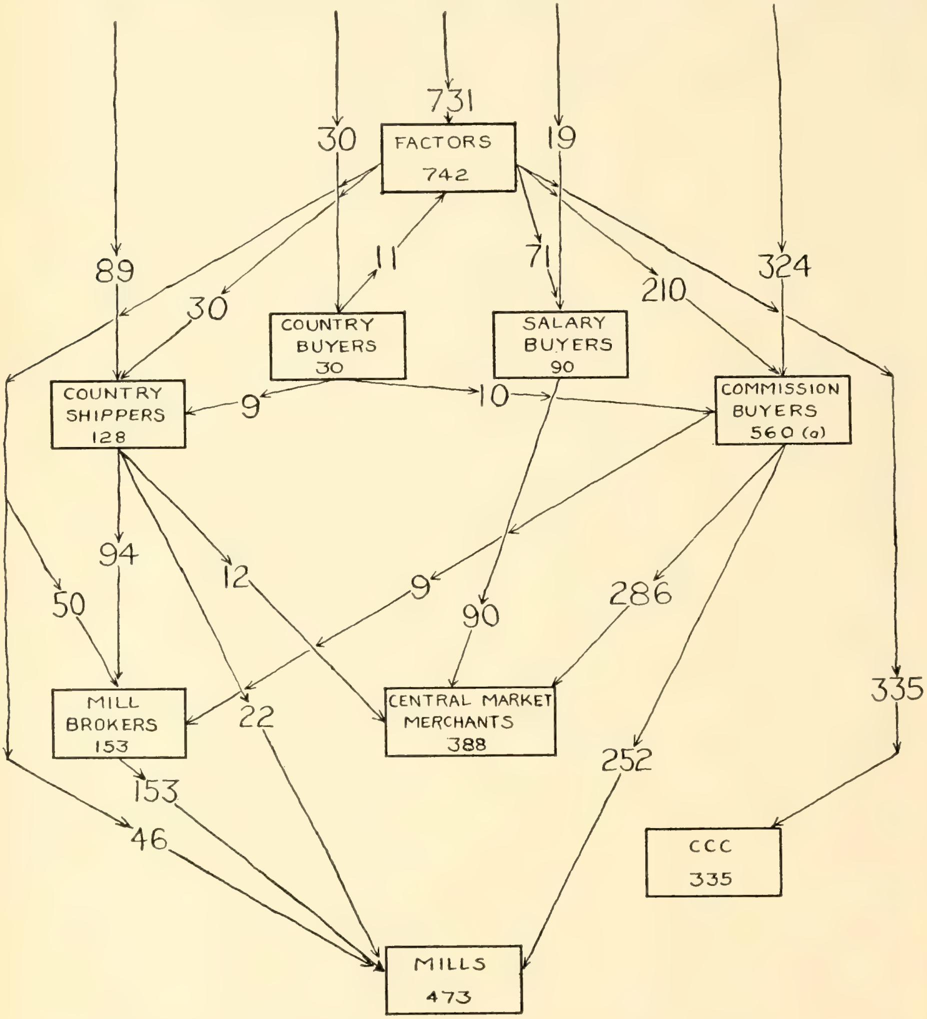
[1] Even though no country buyers were interviewed in the 1960-61 study, these buyers were reported as handling 30,000 bales of cotton. This was cotton that other local market firms reported received from country buyers. See footnote a, Table 2.

[2] Much of the cotton bought by these firms from CCC had been compressed.

VOLUME OF COTTON ENTERING THE MARKET	
From Producers	733
From Non-Delta Farms	243
From CCC	217
Total	1193


731
30
FACTORS 742
19
11
71
89
30
210
324
COUNTRY BUYERS 30
SALARY BUYERS 90
COUNTRY SHIPPERS 128
9
10
COMMISSION BUYERS 560 (a)
94
12
9
286
50
90
335
MILL BROKERS 153
22
CENTRAL MARKET MERCHANTS 388
153
252
46
CCC 335
MILLS 473

(a) Includes 16,000 bales commission firms said they bought from other commission firms and 13,000 bales commission firms said they sold to other commission firms.

Figure 1. Marketing channels for cotton lint entering the market, Delta Area of Mississippi, 1960-61. (Data in thousands of bales).

CHANGE IN VOLUME OF COTTON ENTERING THE MARKET

From Producers	**—372**
From Non-Delta Firms	**+117**
From CCC	**+217**
Total	**—38**

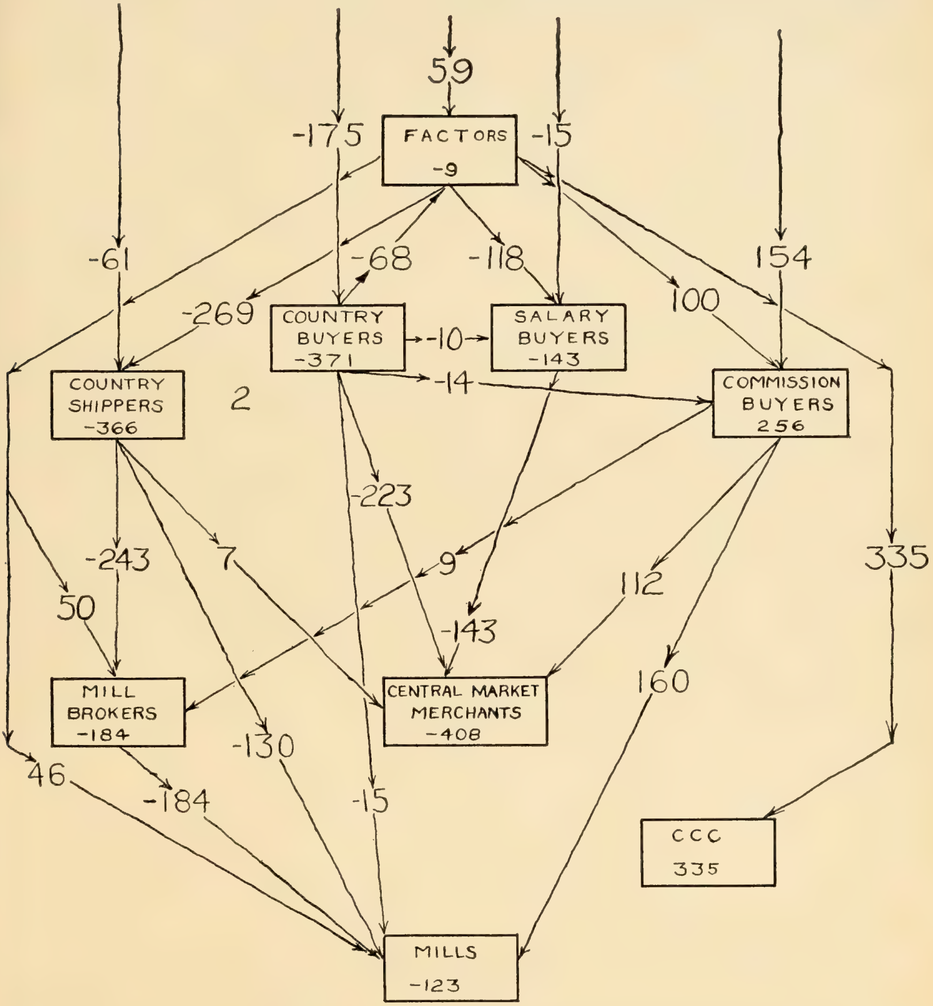

59
-175
FACTORS -9
-15
-61
-68
-118
154
-269
100
COUNTRY BUYERS -371
-10
SALARY BUYERS -143
COUNTRY SHIPPERS -366
2
-14
COMMISSION BUYERS 256
-223
-243
7
9
335
112
50
-143
160
MILL BROKERS -184
CENTRAL MARKET MERCHANTS -408
-130
46
-184
-15
CCC 335
MILLS -123

Figure 2. Changes in marketing channels for cotton lint from 1949-50 to 1960-61, Delta Area of Mississippi. (Data in thousands of bales).

Table 1. Number of firms in the market in 1949-50, number of firms in the sample in the 1949-50 survey and number of firms in the sample in the 1960-61 survey, by size of firm, Delta Area of Mississippi.

Size of Firm	Total number of firms in the market in 1949-50	Number of firms in the sample in the 1949-50 survey	Number of firms in the sample in the 1960-61 survey
(bales handled)		number	
500 - 4,999	49	2	0
5000 - 9,999	39	4	5
10000 -19,999	41	10	8
20000 -34,999	19	9	5
35000 -49,999	7	7	7
50000 -99,999	3	3	7
1000000 and over	1	1	1
Total	159	36	33

chase cotton for central market merchants and receive a salary for this service.

(5) **Commission Buyers.** These buyers purchase cotton for other firms (primarily central market merchants and mills) and receive a per bale commission.

Costs of merchandising[3] cotton were estimated as follows:

1. The total merchandising cost was considered to be the difference in quoted prices for Greenwood, Mississippi and Group B mill points.

2. Standard charges for the physical services rendered shippers by others were taken from the appropriate tariff sheets.
3. The difference between the total merchandising cost and the sum of the standard charges was recorded as unallocated merchandising costs,[4] including profits to shippers.

The status of the ginning industry in 1961-62 was determined by survey. Washington County was chosen as being representative of the area and a complete enumeration of gins in the county was attempted. Usable schedules were completed for 33 of the 41 gins reported by the United States Bureau of the Census as active in the county in 1961.

Possibilities for reducing ginning costs were based on data taken from reports prepared by members of Southern Regional Cotton Marketing Technical Committee, SM-24.

DISTRIBUTION CHANNELS

The 1,193,000 bales of cotton entering the local markets of the Delta Area of Mississippi in 1960-61 was 38,000 bales less than that entering these markets in 1949-50 (Figures 1 and 2). Each bale entering these markets in 1949-50 was handled an average of 1.8 times; 1960-61 market receipts were handled an average of 1.3 times. Thus the total volume handled by local marketing firms was much higher in the earlier period (Table 2).

The smaller turn-over in the latter period suggests the more direct movement of cotton through market channels. This is more illusion than fact. Most of the decline in turnover was the result of the emergence of CCC as an important primary receiver of cotton (Figure 2). Also, declines in the movement from country shippers and salary buyers to mills and central market merchants exceeded increases in the volume handled by commission buyers for mills and for central market merchants.

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[3] The term merchandising, as used here, refers to the performance of all marketing services required in the delivery of even-running lots of compressed cotton to textile mills. Country shippers were the only local market firms engaged in this type of activity as a major part of their business.

[4] Partial allocation of these costs for the 1949-50 season was made on the basis of estimates provided by the country shippers interviewed in the above mentioned survey.

Similar allocations are available for the 1956-57 season. See: Grumby, Billy B. and Cooper, Maurice R., **Cotton Merchandising — Costs, Practices and Problems,** p. 6.

Changes in patterns of distribution between the 1949-50 season and the 1960-61 season are shown in Figure 2 and Table 3. Highlights of these changes were:

1. Declines in

a. Receipts from producers

b. The volume handled by country shippers and salary buyers.

c. The volume going to central market merchants.

d. The volume going to textile mills.

2. An increase in the volume of business done by commission buyers, particularly those representing mills.

3. The virtual disappearance of country buyers from the local market scene.

4. The emergence of CCC as an important source of receipts and as an important market outlet for local market firms.

MARKETING CHARGES

Charges made for services rendered in marketing cotton fit conveniently into two broad categories: (1) Charges for services performed prior to the time that first buyers[5] take title to the cotton and (2)

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[5] First buyers include all buyers who take title to cotton either in their own name or in the name of firms they represent

Table 2. Volume of cotton handled by local marketing firms, by type of firm, by source of receipts, Delta Area of Mississippi, 1960-61 and 1949-50. (In thousands of bales)

	Source of receipts					
Type of firm	Producers	Local factors	Country buyers	CCC	All other sources	Total
				1960-61		
Factors	664	----	19	59	----	742
Country Buyers	30[1]	----	----	----	----	30
Country Shippers	18	43	22	45	----	128
Salary Buyers for Central Merchants	----	71	----	12	7	90
Commission Buyers for Central Merchants	5	197	10	45	21	278
Commission Buyers for Mills	16	166	2	56	42	282
All other Handlers	----	----	----	----	----	----
All Firms	733[2]	477[3]	53[3]	217	70[3]	1550
				1949-50[4]		
Factors	629	----	122	----	----	751
Country Buyers	205	153	43	----	----	401
Country Shippers	110	339	7	----	38	494
Salary Buyers for Central Merchants	11	212	10	----	----	233
Commission Buyers for Central Merchants	71	99	4	----	----	174
Commission Buyers for Mills	32	----	3	----	----	35
All other Handlers[5]	47	26	22	----	----	95
All Firms	1105	829[6]	211[6]	----	38[6]	2183

[1] 30,000 bales bought by other firms from country buyers in the Miss. Delta assumed to have been bought by these country buyers from producers in the Miss. Delta.

[2] 1000,000 bales bought from non-Delta producers.

[3] 243,000 bales bought from non-Delta firms.

[4] Computed from Table 2 of Mississippi Agricultural Experiment Station Bulletin 484.

[5] Commission buyers for mill market shippers and for country shippers.

[6] 126,000 bales bought from non-Delta firms.

Table 3. Disposition of cotton handled by local marketing firms, by type of firm, by market outlet, Delta Area of Mississippi, 1960-61 and 1949-50. (In thousands of bales)

	Market outlet									
Type of Firm	Local Factors	Country Shippers	Central Merchants	Mills	Country buyers	Commission buyers	Salary buyers	CCC	All other buyers	Total
					1960-61					
Factors	----	2	-----	96	-----	264	45	335	----	742
Country Buyers	----	-----	-----	-----	-----	-----	-----	-----	----	-------
Country Shippers	-----	-----	12	116	-----	-----	-----	-----	----	128
Salary Buyers for Central Merchants	----	-----	90	-----	-----	-----	-----	-----	----	90
Commission Buyers for Central Merchants	----	3	273	2	-----	-----	-----	-----	----	278
Commission Buyers for Mills	10	-----	13	259	-----	-----	-----	-----	----	282
All other Handlers	-	--- -	-	- ---	-----	-----	-----	-----	----	-------
All Firms	10	5	388	473	-----	264	45	335	----	1520
					1949-50[1]					
Factors	----	299	- ---	-----	153	21	278	-----	----	751
Country Buyers	79	7	223	1	43	20	14	-----	14	401
Country Shippers	----	-----	5	489	-----	-----	-----	-----	----	494
Salary Buyers for Central Merchants	----	-----	233	-----	-----	-----	-----	-----	----	233
Commission Buyers for Central Merchants	----	-----	174	-----	-----	-----	-----	-----	----	174
Commission Buyers for Mills	----	-----	-----	35	-----	-----	-----	-----	----	35
All other Handlers[2]	----	38	-----	--- -	-----	-----	-----	-----	57	95
All Firms	79	344	635	525	196	41	292	-----	71	2183

[1] Computed from Table 3 of Mississippi Agricultural Experiment Station Bulletin 484.

[2] Commission buyers for mill market shippers and for country shippers.

Table 4. Marketing services rendered and average charges assessed prior to sale of cotton by producers, Delta Area of Mississippi, selected marketing years.

	Average charge per bale					
Service Rendered	1949-50		1956-57		1960-61	
	$		$		$	
Merchandising services		.79[1]		.79[2]		.78[1]
Physical services:[3]		10.43		13.23		14.59
Ginning and wrapping	9.55		12.26		13.42	
Receiving at compress or warehouse	.55		.60		.67	
Storage and insurance for one month	.33		.37		.50	
All services		11.22		14.02		15.37

[1] Brokerage fee per bale computed by dividing total payment by producers to factors by number of bales entering the market: 1,105,000 bales for 1949-50; 1,193,000 bales for 1960-61.

[2] Assumed to be the same as for 1949-50.

[3] Charges from USDA Statistical Bulletin 329.

charges that occur in the distribution of cotton from first buyers to textile mills. These two broad categories may be divided further into charges associated with changes in ownership (merchandising charges) and those associated with physical handling of the cotton.

Direct Charges to Producers

Direct charges to producers in the Delta Area of Mississippi averaged $11.22 per bale in 1949-50; $15.37 per bale in 1960-61 (Table 4). Ginning and physical handling accounted for nearly all of the charges in both years. The ginning charge was the largest item in each year and accounted for over 90 percent of the increase from 1949-50 to 1960-61.

Indirect Charges

In addition to the direct charges to producers, there are indirect charges for the services rendered in the distribution of cotton from first buyers to textile mills. These indirect charges are reflected in the spreads between prices received by producers and prices paid by mills. The average spread between Greenwood, Mississippi, and Group B mills increased from $8.75 per bale in 1949-50 to $11.65 per bale in 1960-61 (Table 5). Slightly more than 80 percent of the increase was for the provision of merchandising services.

Total Charges

The total marketing charge between producers in the Delta and Group B mills increased from $19.97 per bale in 1949-50 to $27.02 per bale in 1960-61 (Table 6). Most of the $4.69 increase in charges for physical services was for ginning. All of the increase in merchandising charges was for services rendered between first buyers and mills.

AREA OF GREATEST POTENTIAL FOR REDUCING MARKETING CHARGES

Charges for three services (ginning, warehousing, and transportation) accounted for the bulk of the total marketing costs in 1960-61. The latter two of these services are provided by regulated industries and reductions in charges are largely beyond the control of producers and merchandising firms. Charges for ginning, on the other hand, are subject to the discretion of the owners of gins. Significant reductions in these charges can be expected if ginning costs can be reduced appreciably.

Changes in the Ginning Industry in Mississippi

Major changes have occurred in the ginning industry in Mississippi since the end of World War II. The number of gins has declined sharply while there has

Table 5. **Estimated per bale charges for marketing cotton between Greenwood, Mississippi, and group B mills, by marketing service rendered, selected marketing years.**

	Average charge per bale		
Service rendered	1949-50	1956-57	1960-61
	$	$	$
Merchandising services:			
Buying and local costs	----	.95[2]	------
Interest and exchange	.42[1]	.85[2]	------
Selling cost	.80[1]	.85[2]	-----
Other (including profit)	1.76[3]	1.94[3]	------
Total	2.98[4]	4.59[4]	5.35[4]
Physical handling			
Compression	1.00[1]	1.15[2]	1.15
Other compress	.60[1]	.70[2]	.90[5]
Transportation	4.17[1]	4.25[2]	4.25
Total	5.77	6.10	6.30
All services	8.75[6]	10.69[6]	11.65[6]

[1] Data from Miss. Agr. Exp. Station Bulletin 484.

[2] Data from Crumley, Billy B. and Cooper, Maurice R., **Cotton Merchandising Costs, Practices and Problems**, Texas Technological College.

[3] Computed as follows: Per bale cost for all services minus the sum of physical handling costs and itemized merchandising costs.

[4] Computed as follows: Per bale cost for all services minus the total of physical handling costs.

[5] 1949-50 costs increased by the percentage increase in compress tariffs from 1949-50 to 1960-61.

[6] Average spread between quoted prices for Greenwood, Miss., and Group B mills for the four major classes of cotton sold in the Delta of Mississippi in 1949-50 (M 1/32, M 1 1/16, SLM 1 1/32, SML 1 1/16 — plus grades included in 1960-61 average). Priced quotations from Agricultural Marketing Service, **Weekly Cotton Market Review.**

Table 6. **Estimated per bale charges for marketing cotton between producers in the Delta Area of Mississippi and Group B mills, by type of marketing service, selected marketing years.**

	Average charge per bale		
	1949-50	1956-57	1960-61
Type of marketing service	$	$	$
Merchandising services	3.77	5.38	6.13
Physical services	16.20	19.33	20.89
All services	19.97	24.71	27.02

Source: Tables 4 and 5.

been no observable trend in the volume of cotton ginned.[6] Ginners have invested heavily in gin equipment. More cleaning and drying equipment has been used to improve the grade of lint from machine-harvested cotton. Capacity has been increased to accommodate more rapid receipts of seed cotton and gin capacity is generally conceded to be excessive. These changes have contributed to the increases in ginning costs which have been reflected in rising charges for ginning.

Description of the Sample County

Changes in the ginning industry have not been uniform among the different producing regions of the state. Data needed to describe the current situation in the Delta were not available. To provide these data a survey was made of ginners in Washington County, a county considered to be representative of the area.

Washington County has a total land area of 465,920 acres with slightly more than 80 percent of the land in farms. In

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[6] The number of active gins in the state averaged 1078 annually for the period 1946-50; 670, for the period 1958-62. The volume of cotton ginned averaged 1,522,000 bales in the earlier period; 1,465,000 in the latter period.

Table 7. Data from a sample of 33 cotton gins, by rated capacity of gins, Washington County, Mississippi, 1961.

Item	Rated capacity of gins in bales per hour								All gins
	3	4	5	6	7	8	9	12	
Age of gins									
Number of gins reporting	2	7	9	4	2	2	2	2	30
Average age in years	10	20	23	23	18	5	37	14	20
Age of gin stands									
Number of gins reporting	2	8	10	5	2	2	2	2	33
Average age in years	10	10	15	14	18	5	18	5	13
Volume ginned									
Number of gins reporting	2	8	8	5	2	2	2	2	31
Average volume in bales	724	2116	2944	3200	2852	4488	6097	5850	3113
Normal hourly output									
Number of gins reporting	2	7	8	5	2	2	2	2	30
Average bales per hour	2.2	3.6	4.1	4.8	4.6	6.1	7.3	6.4	4.5
Days operated									
Number of gins reporting	2	5	9	3	1	2	2	2	26
Average days operated	32	77	73	88	90	95	113	72	78
Days of two-shift operation									
Number of gins reporting	2	8	9	5	1	2	2	2	31
Average no. of 2-shift days	0	15	22	29	30	35	40	12	22
Size of gin crew									
Number of gins reporting	1	7	10	5	2	2	2	2	31
Average number in crew	4	6	6	7	6	8	10	10	7
Book value of gin									
Number of gins reporting	2	7	4	3	--------	0	2	1	19
Average value in dollars	9.7	61.0	66.4	32.5	--------	--------	138.5	190.0	67.2
Charges for ginning									
Number of gins reporting	0	5	7	5	2	2	1	1	23
Average charge in $/bale	-----	11.10	10.45	10.95	10.80	11.28	10.35	10.20	10.79
Charges for bagging and tie									
Number of gins reporting	0	5	7	5	2	2	1	1	23
Average charge in $/bale	-----	4.59	4.85	4.95	4.50	4.87	5.00	4.00	4.76
Total charges									
Number of gins reporting	0	5	7	5	2	2	1	1	23
Average charge in $/bale	-----	15.69	15.30	15.90	15.30	16.15	15.35	14.20	15.55

recent years, about one half of the total area has been in harvested crop land.

Cotton production in the county is dense. From 1958 to 1962, production of cotton per square mile of land area ranged from 87 bales to 166 bales and averaged 138 bales. For this five-year period production density in the eleven-county area averaged 163 bales per square mile and ranged from 104 to 191 bales. In only two of the counties was density lower than in Washington County.

Changes in and Status of the Ginning Industry in Washington County

The number of active cotton gins in Washington County declined from an average of 55 annually in 1946-50 to 41 in 1958-62. The volume of cotton ginned in the county was about the same in the two periods, averaging 102,000 bales annually in 1946-50, 103,000 bales in 1958-62.

The age of gins in the county in 1961 ranged from 4 to 51 years and averaged 20 years (Table 7). Much of the original equipment of these gins has been replaced and the average age of gins stands was 13 years. Also, many of the gins have added seed cotton cleaners, driers and lint cleaners since the gin stands were installed. The majority of the gins now contain the equipment recommended by the USDA ginning laboratory for ginning mechanically harvested cotton.

Despite the decline in number of gins there still is an obvious excess in ginning capacity. The average gin operated only 78 days in 1961. The number of days of two-shift[7] operation was low and on many of the single-shift days the gins operated only for a few hours.

The magnitude of the excess capacity was estimated to be approximately 1600 bales per day. This estimate was derived as follows: Ginnings in the county totaled 33,605 bales in the first two weeks of October, the period of peak receipts in 1961. If the 41 active gins in the county had operated around the clock at the average normal hourly output reported by the sample gins, they could have ginned 53,000 bales in this two-week period.

The excess capacity is reflected in charges for ginning. The total charges reported by the Washington County ginners averaged $15.55 per bale in 1961 (Table 7), $1.08 more than the average reported by the USDA for all gins in the state.

OPPORTUNITIES FOR REDUCING GINNING COSTS

The ideal or perfect gin industry would be one that achieved the minimum per bale ginning cost possible in a given production area. Such an industry would entail the use of the minimum number of gins of optimum size at the most advantageous locations. Members of Southern Regional Cotton Marketing Technical Committee, SM-24 have developed such gin set-ups for representative producing areas.[8]

These researchers used modern high-speed gins in the construction of their models. The rated capacities of the gins used were 3, 4, 6, 8, 9, 10, 12 and 15 bales per hour.[9] The capacity of any gin over a specified period of time was computed by multiplying the hourly capacity of the gin by the number of hours that the gin could be expected to operate during the peri-

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[7] The normal shift for a cotton gin is 12 hours, not all of which is ginning time. Most ginners, when not operating two shifts, will go beyond the normal 12 hours if there is cotton waiting to be ginned. During periods of peak receipts, some of the ginners operated one 18-hour shift rather than two shifts.

[8] See: Louisiana Agricultural Experiment Station Bulletin, No. 577; Southern Cooperative Series Bulletin 88; and Departmental Information Report '64-3, Department of Agricultural Economics and Sociology, Texas Agricultural Experiment Station.

[9] Rated capacity refers to the number of bales of machine-picked cotton that a properly engineered plant can gin in an hour when a continuous and even flow of seed cotton is fed into it.

Table 8. Effect of annual capacity on differences in distribution of seed cotton receipts at gins.

(1)	(2)	(3)	(4)
		Annual capacity with:[2]	
		Percentage of annual ginnings in peak 15-day period	
Gin capacity	Realizable capacity in a 15-day period[1]	27.5[3]	34.4[3]
Bales per hour	Bales	Bales	Bales
8	2,448	8,901	7,116
12	3,672	13,352	10,674
15	4,590	16,690	13,343

[1] 24-hour operation with 15 percent down-time.

[2] Volume in Col. 2 ÷ the percentage of annual ginnings in peak 15-day period.

[3] These are the extremes in peak 15-day ginnings in Washington County, Mississippi in the five-year period, 1958-62. See table 9.

od.[10] (For example, the maximum capacity of a 12-bale-per-hour gin in a 24-hour period with a 15 percent down-time is 244.8 bales.) Annual gin capacity was considered to be the amount of cotton that a ginner could expect to receive within the framework of some assumed distribution of seed cotton arrivals at the gin. The determinant of the annual capacity of a gin was taken to be the amount of cotton that could be ginned during the two-week period of peak receipts.[11]

The annual capacity of a 12-bale-per-hour gin in Washington County would have ranged from 10,674 bales to 13,352 bales during the period 1958-62 (Table 8). These capacities were derived as follows: In 1958, gins in the county received 27.5 percent of their total volume in the peak 15-day period; the comparable percentage for 1962 was 34.4 (Table 9). A gin of this hourly capacity operating around the clock with 15 percent down-time could gin 3672 bales in a 15-day period. This volume is 27.5 and 34.4 percent, respectively, of 13,352 and 10,674.

Twelve gins of 12-bale-per-hour capacity could have ginned the volume of cotton received by Washington County gins from Sept. 16 to Oct. 1, 1962, the 15-day period of peak receipts in the years 1958-62 (Table 9). Ten 15-bale gins could have handled peak receipts in this period. The volume of cotton available per gin in 1962 would have averaged more than 10,000 bales for the number of 12-bale gins; 12,500 for the 15-bale gins. For the 4-year period, 1959-62[12] 12-bale gins would have averaged 9,500 bales; 15-bale gins, more than 11,000.

Volume of production and the pattern of receipts at gins in an area determine the size of gin that will give minimum per bale ginning cost. For volumes that gins in the Delta of Mississippi could expect to receive, the larger the gin, the lower are ginning costs per bale. The 11,000 bales that a 15-bale gin could have averaged in Washington County in 1959-62 could have been ginned for a total per bale cost of $9.80 (Table 10). The per bale cost of the 12-bale gin for its 9500 bale volume would have been about $10.00. The cost for either gin would have been significantly less than the average charges reported by Washington County ginners in 1961.

Combined Costs of Assembling and Ginning

Attainment of the volume needed to realize the cost reductions possible through the use of a restricted number of

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[10] The Louisiana and Texas studies cited above used 15 percent down-time; the Southern Regional study, 20 percent. The 15 percent figure appears more reasonable for a modern gin in the Delta of Mississippi. See: Annual Meeting, American Society of Agricultural Engineers, Paper no. 62-151, 1962.

[11] Louisiana Agricultural Experiment Station Bulletin, No. 577, pp. 23-24.

[12] 1958 is excluded from the average because this was a year of heavy participation in the acreage reserve program.

Table 9. Cotton ginnings: Distribution by specified time periods, Washington County, Mississippi, 1959 to 1962.

Year	Prior to Sept. 16	Sept. 16 to Oct. 1	Oct. 1 to Oct. 18	Oct. 18 to Nov. 1	Nov. 1 to Nov. 14	After Nov. 14	Total
				Bales			
1958	276	1,014	14,689	17,717	9,607	21,076	64,379
1959	11,445	27,601	32,945	25,215	9,994	8,803	116,003
1960	6,662	19,364	26,525	23.658	11,209	11,945	99,363
1961	1,043	13,071	33,605	33,547	13,003	18,287	112,556
1962	37,089	42,986	29,991	8,946	3,417	2,579	125,008
			Percent of annual ginnings				
1958	.4	1.6	22.8	27.5	14.9	32.7	100
1959	9.9	23.8	28.4	21.7	8.6	7.6	100
1960	6.7	19.5	26.7	23.8	11.3	12.0	100
1961	.9	11.6	29.8	29.8	11.6	16.2	100
1962	29.7	34.4	24.0	7.2	2.7	2.1	100

Source: U. S. Dept. of Commerce, Bureau of the Census, **Cotton Production in the United States.**

Table 10. Cotton ginning: Per-bale cost, 12-bale-per-hour and 15-bale-per-hour gins, two hourly wage rates, selected annual volumes, 1961-62.[1]

	12-bale per hour gin		15-bale per hour gin	
	Hourly wage rate		Hourly wage rate	
Annual volume	$1.00	$1.25	$1.00	$1.25
Bales	Dollars	Dollars	Dollars	Dollars
8,000	10.70	10.90	11.50	11.70
9,000	10.20	10.35	10.80	11.00
10,000	9.70	9.85	10.25	10.45
11,000	9.30	9.45	9.80	10.00
12,000	9.00	9.15	9.45	9.65
13,000	8.70	8.85	9.10	9.30

[1] Baggings and ties charged at $2.50 per pattern. Costs shown are for conditions in Louisiana. Minor variations from these costs would occur in the Delta of Mississippi because of differences in electricity rates, availability of natural gas, etc. However, the general relationship of costs to scale would remain relatively unchanged.

Computed from Table 9 and Appendix Tables 15 and 16 of Louisiana Agricultural Experiment Station Bulletin No. 577.

high-capacity gins would necessitate an increase in the size of the supply area served by gins. The resulting increase in the cost of assembling seed cotton would offset some of the decrease in ginning costs. However, ginning costs decline more rapidly than assembly costs increase and the combined costs of assembling and ginning declined over the entire range of relevant volumes (Table 11). Adding assembly costs virtually eliminates the ginning cost advantage of the 15-bale gin. The 15-bale gins could have assembled and ginned 11,000 bales for a cost of about $11.66 per bale; the 12-bale gins, 9500 bales for a cost of about $11.70.[13]

Combined Costs of Seed Cotton Storage and Ginning

Consideration was given to the feasibility of seed cotton storage as a means of decreasing ginning costs by achieving greater seasonal utilization of gin-plant equipment.[14] Cost comparisons were made between the gin-storage method of achieving a given annual capacity and a new gin with equivalent annual capacity.

These comparisons indicate that when only new gins are considered (that is, a

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[13] Absorption of assembly cost by the ginner would eliminate the current cost of assembly normally borne by producers.

[14] For estimates of pre-bale storage costs see Table 20 of Louisiana Agricultural Experiment Station Bulletin No. 577.

Table 11. Cotton ginning: Combined per-bale cost of assembly and ginning 12-bale-per-hour and 15-bale-per-hour gins, two hourly wage rates, two levels of production density, selected annual volumes, 1961-62.[1]

	12-bale-per-hour-gin		15-bale-per-hour-gin	
	Hourly wage rate[2]		Hourly wage rate[2]	
Annual volume	$1.00	$1.25	$1.00	$1.25
Bales	Dollars	Dollars	Dollars	Dollars
		100 bales per square mile		
8,000	12.35	12.55	13.15	13.35
9,000	11.92	12.07	12.52	12.72
10,000	11.50	11.65	12.05	12.25
11.000	11.16	11.31	11.66	11.86
12,000	10.93	11.08	11.38	11.58
13,000	10.69	10.84	11.09	11.29
		200 bales per square mile		
8,000	12.00	12.20	12.80	13.00
9,000	11.55	11.70	12.15	12.35
10,000	11.10	11.25	11.65	11.90
11,000	10.75	10.90	11.25	11.45
12,000	10.50	10.65	10.95	11.15
13,000	10.24	10.39	10.64	10.80

[1] See footnote to Table 10.

[2] The two wage rates apply to ginning cost only. A wage rate of $1.00 was used in computing assembly costs.

Taken from Appendix Tables 15 and 16 of Louisiana Agricultural Experiment Station Bulletin No. 577.

new gin with a storage system versus a new gin with equivalent annual capac- without storage), lower ginning costs per bale result when the initial investment is made in a gin plant sufficiently large to handle the anticipated volume without storage.[15]

This conclusion is valid only for those ginners contemplating the construction of new gins. Those with an investment in a serviceable gin are faced with an entirely different situation. They could increase volume through the storage of seed cotton at lower costs than they could by investing in a new gin of larger capacity. Also, owners of low-capacity gins would do well to consider the feasibility of increasing volume by the addition of one or more gin stands to existing facilities.

[15] Louisiana Agricultural Experiment Station Bulletin No. 577, p. 60.

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SUMMARY AND CONCLUSIONS

Channels of distribution of cotton in local markets of the Delta of Mississippi changed significantly from 1949-50 to 1960-61. The volume of cotton received by local market firms from producers declined importantly; that received from non-Delta firms and from CCC increased. Country buyers virtually disappeared from the scene and CCC emerged as an important source of receipts and as an important market outlet for local market firms. The volume of cotton going to textile mills declined and commission buyers supplied these firms with large volumes of cotton formerly sold to them by country shippers.

The total marketing charge between producers in the Delta area of Mississippi and Group B mills increased from $19.97 per bale in 1949-50 to $27.02 per bale in 1960-61. The increase between producers and first buyers was $4.15 per bale; that between first buyers and mills $2.90. Most of the increase between producers and first buyers was for ginning. Ginning charges were responsible for almost half of the total marketing spread in both years.

The relatively high charge for ginning is, in part, attributable to a large excess capacity in the ginning industry. Survey data from Washington County revealed the magnitude of this excess. The 41 active gins in the county in 1961 operated an average of only 78 days and the number of days of two-shift operation was low. If the 41 gins had operated around the clock at the average realized rate of ginning reported by a sample of gins, they could have ginned 1600 bales per day more than their realized volume in the period of peak ginnings in 1961. Charges by ginners in the county averaged $15.55 per bale in 1961, $1.08 more than the average reported by the USDA for all gins in the state.

Ginning costs could be lowered appreciably if the ginning industry consisted of the minimum number of gins of optimum size at advantageous locations. Twelve gins of 12-bale-per-hour capacity could have ginned the volume of cotton received by Washington County gins in the two-week period of peak receipts in the years 1958-62. Ten 15-bale-per-hour capacity gins could have handled peak receipts in this period. The volume of cotton available in the 4-year period, 1959-62, would have averaged 9500 bales annually for the 12-bale gins; 11,000 bales for the 15-bale gins. The 9,500 bales available to the 12-bale gins could have been ginned for a total per bale cost of about $10.00. The per bale cost of a 15-bale gin for the 11,000 bales available to it would have been $9.80.

Realization of these cost reductions would necessitate an increase in assembly costs because the size of the supply area served by individual gins would be increased. However, ginning costs decline more rapidly than assembly costs increase and the combined costs of assembling and ginning declined over the entire range of relevant volumes. The addition of assembly costs removed the slight cost advantage enjoyed by the 15-bale-per-hour capacity gin.

An alternative method of increasing volume as a means of decreasing ginning costs is the storage of seed cotton at gins. Where only new gins are considered this method is not practical. Lower ginning costs result when the initial investment is in a gin large enough to handle the anticipated volume without storage.

For those ginners with investment in a low-capacity gin, seed cotton storage is practical. Volume can be increased through storage at less cost than by investing in a new gin of larger capacity.

Also worthy of consideration by the owners of low-capacity gins is the feasibility of increasing volume by the addition of one or more gin stands to existing facilities.

BULLETIN 707 MAY 1965

Various Methods Of
Horn Fly Control In Beef Cattle

By H. W. Essig and W. A. Pund

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Summary

Horn fly populations were reduced 50 to 60% when a mineral block containing 5.5% ronnel was fed as compared to animals given a mineral mix without ronnel and being sprayed with marlate as needed in addition to having access to a backrubber.

Animals given access to a mineral mix containing 5% phenothiazine gained significantly faster than the marlate treated cattle.

Cows given access to backrubbers containing marlate gained significantly more than cows with backrubbers containing rulene.

Cows given thiabendazole drench or given access to a mineral block containing ronnel gained significantly less than marlate treated cows.

Phenothiazine administered in the mineral mixture appeared to be about equal to marlate spraying and marlate backrubbers for horn fly control.

There was no influence on calf gain when the cows were given various horn fly control treatments.

VARIOUS METHODS OF HORN FLY CONTROL IN BEEF CATTLE

By H. W. ESSIG AND W. A. PUND

Horn flies continue to be a problem for livestock producers as well as a discomfort to animals. In a continuous search for control, such methods as sprays, backrubbers, pour-ons and ingested compounds are constantly being evaluated.

The research reported here was conducted by the Mississippi Agricultural Experiment Station to study some of the compounds administered in various methods in controlling horn flies as well as the relation of these products to the gain of the animals used in different treatments.

The study involved three separate trials and included a total of 231 cattle. All trials ran concurrently with the first insect counts being made on June 22, 1964 and the last on October 12 of the same year.

Since results were to be measured as animal weight changes, horn fly counts, and worm egg counts[1] in the feces, thiabendazole was included to control internal parasites. This compound is not specifically related to horn fly control. The other compounds (ronnel and phenothiazine) are related to horn fly control by theoretically killing the horn fly larvae which hatch in the cattle manure.

Trial I

Seventy-six yearling heifers, at the Animal Husbandry Prairie Station were divided into four treatment groups as shown in Table 1. All groups were sprayed with marlate at the start of the experiment. Throughout the test all had access to mineral salt, regardless of whether or not it contained insect control medication.

Treatments were as follows:

1.Sprayed with marlate as needed plus backrubbers containing marlate in deisel fuel. This is the normal practice with which the other treatments were compared.

2. Same as 1 for the first 53 days. Then in addition to marlate backrubbers, a 5.5% ronnel mineral block was used. (To control internal parasites and determine their effect on weight changes, each animal in this group was also given a 6 gm thiabendazole drench per 100 lbs body weight at the start of the test and 56 days later).

3. Mineral salt containing 5% phenothiazine.

4. Mineral block containing 5.5% ronnel, except for three weeks when the ronnel was inadvertantly discontinued.

Weekly fly counts were made on three heifers of each breed in each group. The counts were made through binoculars from a distance so not to disturb the animals or flies. All animals were weighed at the start and upon termination of the test. A record of fly control material application and fly control material consumption was kept for each treatment group.

Results: Results of this trial are shown in tables 1 and 2.

Heifers in treatment 3 which were given the mineral salt containing 5% phenothiazine gained faster than those in the other three treatment groups.

All treatment groups were maintained on pastures which apparently contained adequate forage. Therefore, the difference in gain should not be attributed to pasture difference. The increase in gain was apparently not due to a reduction in horn fly population since the animals with access to phenothiazine had a fly population equal to the control group. The egg

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[1] Worm egg counts were made by R. A. Knight, USDA parasitologist, State College.

Table 1. Gain, consumption, egg count and fly counts for heifers given various fly control treatments for 138 days. (Trial 1)

Treatment No.	1	2		3	4	
No. Animals	19	19		19	19	
Shorthorn	2	3		3	3	
Hereford	11	10		10	10	
Angus	6	6		6	6	
Av. I. Wt., lb.	568	570		565	550	
Av. F. Wt., lb.	649	661		702	636	
Av. Daily Gain, lb.	0.59	0.66		0.99**	0.62	
Consumption (salt, medicant)						
Mineral Block, kg.	90.8	45.4		----	22.7	
Phenothiazine — Salt, kg.	----	----		72.6	----	
Ronnel block, kg.	----	78.9		----	116.1	
Gm. Cons/d/100 lb. B. Wt.	5.68	7.70		4.36	8.93	
Gm. Medicant/100 lb. B. Wt./day	0	----		0.218	0.491	
Egg Counts						
No. Animals	9	8		8	9	
Range (eggs per gram feces)	0-268	0.112		8-233	2-268	
Av. Egg Count (EPG)	98	29		67	48	
Fly Count (on right side)						
Hereford	49	42[1]	19[2]	43	12[3]	48[4]
Angus	59	57	20	62	23	55
Shorthorn	----	43	11	50	22	40
Average fly count	54	47	17	53	19	48

**Significantly higher than all other treatments.

[1] First 53 days on mineral block

[2] Last 85 days on ronnel-mineral block

[3] Entire period when ronnel block fed

[4] 3 week period when ronnel block not fed

Table 2. Average fly counts on the right side of heifers given various fly control treatments. (Trial 1)

	Treatments			
Date	1.	2.	3.	4.
6-4-64 Experiment started, all cattle sprayed with marlate				
6-22	88	54	32	8
6-29	14	39	36	15
7-6	60	26	51	34
7-13	57	39	40	23
7-20	121	64	96	12
7-27[1]	93	62	84	60[3]
8-3	28	21[2]	101	50[3]
8-10	46	10	44	34[3]
8-17	33	14	50	20
8-23	71	18	48	13
8-31	34	----	----	19
9-7	98	10	22	19
9-14	14	19	36	9
9-21	23	23	31	41
9-28	53	19	70	23
10-5	----	17	38	13
10-12	28	20	----	14
10-20-64 Experiment ended				
Mean	53.7	16.9[4]	52.6	18.8[5]

[1] Lot 1 sprayed 7/30 with marlate

[2] Changed from mineral block to ronnel block after 53 days

[3] Mineral block fed in place of ronnel block

[4] After ronnel added

[5] Excluding 3 weeks when ronnel not used.

counts per gram feces were in the same range treatments.

These observations would indicate that the mineral-salt mixture containing phenothiazine through some criteria other than those tested in this trial apparently caused an increase in average daily gain. Many workers have reported increases in gain of phenothiazine treated animals when compared to controls receiving no phenothiazine. One such report was published in Mississippi Farm Research last June. These increased gains due to phenothiazine have ranged from 20 to 60 pounds per animal depending on the length of the trial.

The horn fly population for the animals on the various treatments (table 2) indicated that when the mineral blocks which contained ronnel were fed, horn flies were reduced by about 66%. The reduction, however, did not influence the average daily gain of the animals in this study.

Trial II

One hundred twenty-three Angus cows, at the Animal Husbandry Prairie Station, were divided into four treatment groups on the basis of age and sire relationship. All treatment groups were sprayed with marlate at the start of the experiment. Treatment groups were as follows: (5) Sprayed with marlate as needed and having access to backrubbers containing marlate in diesel fuel; (6) Same as 1 for fly control plus internal parasite control treatment of 3 gm thiabendazole per 100 lb. body weight at the start of the test and 56 days later; (7) Mineral salt containing 5% phenothiazine; (8) Mineral block containing 5.5% ronnel. Treatment groups 5 and 6 were given mineral without ronnel or phenothiazine

Weekly fly counts were made as in Trial 1 on 6 cows in each treatment group. All cows and calves were weighed at the start and upon termination of the test. All were moved to a different pasture each 28 days in an attempt to remove differences due to pasture.

Again the group which received phenothiazine gained significantly faster than the other groups. (Table 3). This significant increase in gain was true for the phenothiazine treatment group when the data were calculated for either the cows with calves or the cows with and without calves. The phenothiazine treatment group of cows gained about 25 pounds more per animal than the marlate treated controls. The marlate treated group gained about 25 pounds more per animal than the remaining treatment groups.

The administration of thiabendazole and ronnel, in this test, significantly depressed gains for the cows with calves and for the total group of those with and without calves.

Even though gains of cows was influenced by treatment, there was no significant effect on the gain of the calves. The gain of the calves on the marlate treatment was apparently lower than the other treatments however, this difference was not significant.

The weekly horn fly count indicated that the ronnel treatment group had about 50% less horn flies than the marlate control treatment (table 4). These data also indicate that phenothiazine is about equal to the normal marlate practice in controlling horn flies with marlate sprays and backrubbers.

Trial III

Trial III was set up to compare marlate and rulene in backrubbers. Thirty-nine Shorthorn cows were divided into two treatment groups on the basis of age and sire relationship. Cows in treatment 9 had access to a backrubber which contained marlate in diesel fuel. In treatment 10 the backrubber contained rulene in diesel fuel. Fly counts were determined in the same manner as described in Trial II. Each group of cows and calves were moved to a different pasture each 28 days in order to minimize pasture difference.

Table 3. Influence of different methods of horn fly control on cows and calves for 142 days.

Treatment	Trial II			Trial III		
No.	5	6	7	8	9	10
No. Cows	30	31	30	32	20	19
Av. I. Wt., lb.	807.0	792.2	830.0	811.7	792.5	819.2
Av. F. Wt., lb.	937.7	893.0	991.7	922.4	921.6	891.6
Av. Gain, lb.	130.7	100.8	161.7	110.7	129.1	86.6
Av. D. G., lb.	0.90	0.71*	1.14**	0.78*	0.91	0.61**
No. Cows W/calves	24	24	22	22	14	13
Av. I. Wt., lb.	824.0	807	856.8	830.5	787.5	858.8
Av. F. Wt., lb.	936.6	886.8	992.7	913.8	887.3	904.1
Av. Gain, lb.	112.9	79.3	135.9	78.8	99.8	45.2
Av. D.G., lb.	0.79	0.56**	0.96**	0.59**	0.70	0.32**
No. Calves	24	24	22	22	15	13
Av. I. Wt., lb.	170.0	194.0	196.4	177.3	186.3	164.3
Av. F. Wt., lb.	393.6	426.1	434.6	411.4	411.0	384.6
Av. Gain, lb.	223.6	232.1	238.1	234.1	224.7	220.3
Av. D. G., lb.	1.57	1.63	1.67	1.65	1.58	1.55
Av. Grade[1]	10.3	10.6	11.2	10.9	11.2	10.5
Gm. Cons./100 lb. B. Wt.	275.4	332.5	305.8	502.3	314.7	409.1
Gm./day/100 lb. B. Wt.	1.94	2.34	2.15	3.54	2.22	2.88
Av. Fly Count	65.4	74.5	72.0	30.0	57.9	48.4
Worm Egg Counts: (EPG)						
No. Animals	19	16	14	10	----	---
Range	0-492	10-820	8-772	6-376	----	----
Av. Egg Count	150	169	217	125	----	----

*Significantly (P .05) different from marlate treatment

**Significantly (P .01) different from marlate treatment

[1] Grade code: low good 9, Av. good 10, high good 11, low choice 12

Table 4. Average fly counts on right side of 6 cows in each treatment group. Trials II and III.

Treatment	Trial II			Trial III		
No.	5	6	7	8	9	10
6-22	10	41	56	14	36	13
2-29	20	52	37	32	35	21
7-6	44	97	88	21	33	22
7-13	65	101	69	27	48	29
7-20	129	154	106	32	66	54
7-27	65	86	144	63	53	46
8-3	79	122	160	29	58	43
8-10	107	114	110	31	83	63
8-17	57	65	88	24	46	34
8-23	82	120	103	53	136	87
8-31	139	68	54	22	36	63
9-7	33	18	17	23	52	31
9-14	63	30	35	20	31	68
9-21	61	75	49	21	68	58
9-28	97	60	50	45	106	86
10-5	22	24	28	25	40	51
10-12	38	40	30	21	40	51
Mean	65.4	74.5	72.0	30.0	57.9	48.4

Results: In this trial the group given access to a backrubber containing ruelene had a smaller horn fly population than the marlate group (Table 4) but they gained significantly less. There was no influence on calf gains in the two treatment groups.

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Foliar Application Of Phosphorus For Cotton

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FOLIAR APPLICATION OF PHOSPHORUS FOR COTTON

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Because of the emphasis on foliar application of nutrients to cotton, especially in the Mississippi Delta Area, many questions are being asked regarding the value of this practice in cotton production.

Foliar feeding of plants is not a new thing. That plants will absorb nutrients applied in solution to their leaves and use them effectively is well established. Whether or not foliar feeding is feasible depends on a number of factors, among them being the amount of nutrient required and the number of applications needed to correct a deficiency.

Because they are required in very small quantities, foliar feeding of "trace elements" or micronutrients, such as boron, is feasible and has become a standard practice in some areas. This practice is especially advantageous where availability of the nutrient cannot be maintained adequately by soil application. Foliar application often can be made conveniently and inexpensively with insecticides and fungicides. Application of boron to cotton with the insecticide during the fruiting period is a good example.

Because they are required in large amounts, foliar feeding of nitrogen, phosphorus, and potassium generally has not been found to be practical. This is because frequent application of small amounts is required to correct a substantial deficiency without injury to the leaves. Even so, there has been considerable emphasis as to the advantages of foliar feeding of cotton with NPK solutions during the fruiting period, particularly in the latter part as a heavy boll load is developed. Under these conditions, it is contended that uptake of phosphorus, for example, by cotton roots is inadequate to meet the demand and, as a result, foliar feeding is necessary to get maximum yields. Even if not necessary for maximum yields, foliar feeding of phosphorus might be practical if a much higher percentage of the phosphorus were utilized when applied to the leaves than when applied to the soil.

In previous experiments by the Mississippi Agricultural Experiment Station it was shown that foliar feeding of nitrogen to cotton during the fruiting period was not necessary for maximum yields, but yields were increased where there was insufficient nitrogen in the soils. Because of the lack of experimental information regarding foliar feeding of phosphorus to cotton, experiments were conducted in 1964 by the Mississippi Agricultural Experiment Station to: (1) determine the effect of foliar feeding of phosphorus on the yield and maturity of cotton at different levels of available soil phosphorus and at different rates of fertilizer phosphous applied before planting; and (2) measure the efficiency of foliar-applied phosphorus; and (3) determine the effect on yield of foliar application of phosphorus during the latter part of the fruiting period.

EXPERIMENTAL METHODS

Three field experiments and one simulated (cylinder) field experiment were conducted. The field experiments were located at the Black Belt Branch Station on Houston clay soil, very low in available phosphorus; at the Pontotoc Ridge-

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[1] The authors wish to express appreciation to B. C. Hurt, Jr. and R. E. Coats for their cooperation in carrying out field experiments on the branch stations.

The information in this report was taken from a Master's Degree thesis by the junior author.

Flatwoods Branch Station on Atwood silty clay loam, low in available phosphorus; and at the Central Station on Kaufman fine sandy loam, high in available phosphorus.

At the Black Belt Branch Station the treatments consisted of rates of soil-applied phosphorus varying in 30-pound increments from zero to 120 pounds of P_2O_5 per acre both with and without foliar application of phosphorus. At the Pontotoc Ridge-Flatwoods Branch Station foliar feeding was compared with soil application of phosphorus. The rates of soil-applied phosphorus were 0, 30, and 60 pounds of P_2O_5 per acre. Two schedules of foliar application were employed, one beginning early and one later in the fruiting period.

Two sources of phosphorus, monoammonium phosphate and sodium polyphosphate, were compared for foliar application at the Pontotoc Ridge-Flatwoods and the Black Belt Branch Stations.

Two rates of phosphorus, 0 and 120 pounds of P_2O_5 per acre, were employed at the Central Station both with and without foliar application of phosphorus. There were two schedules of foliar feeding, one commencing early and one later in the fruiting period.

In each of the field experiments, ammonium nitrate and ordinary superphosphate were the sources of nitrogen and phosphorus, respectively. Muriate of potash was the source of potassium except at the Black Belt Branch Station where it was Sul Po Mag, a fertilizer containing both potassium and magnesium. Soils of the Blackland area, where the Black Belt Branch Station is located, are often deficient in magnesium for cotton. At each location the rate of potassium was 60 pounds of K_2O per acre; the rate of nitrogen was 80 pounds per acre except at the Black Belt Branch Station where 100 pounds per acre was applied. All fertilizers except those sprayed on the leaves were applied to the soil prior to planting the cotton.

In order to limit the effect of environmental factors such as drought and low light intensity on yield, and to intensify the need of plants for phosphorus during the fruiting period by increasing the yield per plant, cotton was grown in widely spaced cylinders (rims) that could be irrigated as needed. The experimental site was on Shubuta fine sandy loam at the Central Station, State College, Mississippi.

The cylinders, or rims, were constructed of sheet aluminum and were two feet in diameter and one foot deep. Holes were dug into which the cylinders were nested. The cylinders were arranged in rows of ten and the distance, from center to center, between adjacent cylinders was 8 feet. Each cylinder was filled with Brooksville clay soil which was very low in available phosphorus. The soil was taken from the Black Belt Branch Station.

The treatments applied to the cylinders consisted of five rates of phosphorus both with and without foliar application, the rates being 0, 2.9, 5.8, 8.8, and 11.7 grams of P_2O_5 per cylinder. Ordinary superphosphate was the source of phosphorus for soil application. In addition to the phosphorus treatments, all cylinders received 50 pounds of nitrogen as ammonium nitrate and 100 pounds of K_2O as Sul Po Mag prior to planting. Each cylinder was top dressed with additional nitrogen as ammonium nitrate on June 26, July 23, and August 15, at rates of 5.5, 5.5, and 3.6 grams per cylinder, respectively.

A preliminary experiment was conducted to determine what sources of phosphorus and solution concentrations might be best for foliar application. From these results it was evident that very dilute solutions would have to be used to avoid injury to the leaves. Solutions of monoammonium phosphate and of sodium polyphosphate (mixture of orthophosphoric acid and sodium pyrophosphate) ranging in concentration up to one percent

Cotton growing in cylinders to intensify the need for phosphorus during the experiment.

P_2O_5 caused no noticeable injury. Stronger solutions injured the leaves, and the degree of injury increased with increasing concentration of P_2O_5. Solutions containing two percent P_2O_5 caused noticeable burning of the leaves. Solutions of orthophosphoric acid containing as little as 0.5 percent P_2O_5 burned the leaves. As a result of these experiments, monoammonium phosphate was selected as the source of phosphorus for foliar application, but sodium polyphosphate was included for comparison at the Black Belt and Pontotoc Ridge-Flatwoods Branch Stations.

Foliar application of phosphorus was begun on July 20, at the Black Belt Branch Station; on July 21, at the Pontotoc Ridge-Flatwoods Branch Station; on July 13, at the Central Station; and on July 14, in the cylinder experiment at the Central Station, State College, Mississippi. Late-season foliar feeding was begun on August 5, at the Central Station and on August 6, at the Pontotoc Ridge-Flatwoods Branch Station.

The rate of foliar-applied phosphorus varied with the stage of development of the plants. At the beginning of the spray program a solution containing 0.6 percent P_2O_5 was employed. Later it was increased to 0.7 percent and then to 0.8 percent of P_2O_5. Late in the season when the leaf area was at, or near maximum, the amount of P_2O_5 applied to the foliage was increased by increasing the volume of solution applied.

In the beginning two applications per week were intended. However, this schedule had to be abandoned because of weather conditions and the foliar applications were made approximately once per week. Of a total of some twelve foliar applications of phosphorus at least four were washed off by rain before 24 hours had elapsed. Such applications were disregarded in calculating the total amount of foliar-applied phosphorus because with some other plants it has been found that a 24 hour period was required for absorption of 50 percent of the phosphorus applied to the leaves. The schedule for foliar application of phosphorus for all the test locations is given in Table 1. The amount of phosphorus per application varied from 1.5 to 3.5 pounds of P_2O_5 per acre while the total applied varied from 14.4 to 21.7 pounds of P_2O_5 when application was begun early and from 7 to 13.4 pounds when begun late in the fruiting period.

In the field experiments the nutrient solution was sprayed on the cotton with a compressed air, garden-type sprayer and in the cylinder experiment with a hand-operated atomizer.

In order to obtain a measure of the effect of the various treatments on the earliness of cotton, two harvests were made in each of the field experiments and three in the cylinder experiment.

RESULTS AND DISCUSSION

Yield results for the field experiments are given in Tables 2, 3, and 4 and for the cylinder experiment in Table 5. A response to soil application of phosphorus was obtained in all experiments

Table 1. Schedule for foliar application of phosphorus in field and cylinder experiments and rate per application.

Location of Experiment	July: Rate of P_2O_5/A per application and number made		August: Rate of P_2O_5/A per application and number made		September: Rate of P_2O_5/A per application and number made		Total P_2O_5 applied
	Rate	Number	Rate	Number	Rate	Number	
Black Belt							
Branch Station	1.50	3	2.66	5	------	-	17.8
Pontotoc Branch Station							
Beginning Early	1.90	3	2.62	5	2.90	1	21.7
Beginning Late	--------	-	2.62	4	2.90	1	13.4
Central Station							
Beginning Early	2.46	3	3.50	2	-----	--	14.4
Beginning Late	-----	--	3.50	2	-----	-	7.0
Central Station							
In Cylinders[1]	0.16	4	0.24	3	0.24	1	1.6

[1] Rate is given as grams of P_2O_5 per cylinder.

Table 2. Effect of soil and foliar application of phosphorus on the yield and maturity of cotton on Houston clay at the Black Belt Branch Station.

Treatment pounds of P_2O_5		Pounds of seed cotton[2]		
Soil	Foliar	Total	Increase for foliar feeding	Percent at first picking
0	0	2308 c	------	44
0	17.8	2436 bc	128	47
30	0	2372 c	------	51
30	17.8	2508 ab	136	48
30	17.8[1]	2544 ab	172	50
60	0	2528 ab	----	51
60	17.8	2576 a	48	49
90	0	2580 a	-----	49
120	0	2376 c	-----	47
120	17.8	2364 c	—12	52
		c.v.=11.9%		

[1] Applied as sodium polyphosphate.

[2] Any two values not followed by the same letter are significantly different from each other at odds of 19:1.

except the one at the Central Station on Kaufman fine sandy loam which was high in available phosphorus. The yield response of cotton to foliar application of phoshorus depended altogether upon the level of available phosphorus in the soil, whether present naturally or as a result of fertilization. Significant increases in yield from foliar application of phosphorus were obtained at the Pontotoc Ridge-Flatwoods Branch Station and in the cylinder experiment at the Central Station. Increases in yield for foliar application were obtained at the Black Belt Branch Station, but they were not statistically significant at odds of 19:1.

From the results at the Black Belt Branch Station and in the cylinder experiment, it is evident that the response of cotton to foliar application of phosphorus decreased with increasing rates of phosphorus applied to the soil until finally there was no increase at all for foliar application. The rate of soil-applied phosphorus at which foliar application no longer increased the yield coincided with the rate needed for maxmum yield.

Where there was no increase in yield from a soil application of phosphorus, as in the field experiment at the Central Station, then, there too was no increase for foliar application of phosphorus. For example, in the field experiment at the Black Belt Branch Station foliar application of phosphorus increased the yield of seed cotton 128 pounds per acre where phosphorus was not applied to the soil; but when 60 pounds of P_2O_5 was applied, there was essentially no increase for foliar application.

These results clearly indicate that foliar feeding of phosphorus during periods of high nutrient needs, as may be engendered by development of a heavy boll

Table 3. Effect of soil and foliar application of phosphorus on the yield and maturity of cotton on Atwood silty clay loam at the Pontotoc Ridge-Flatwoods Branch Station.

Treatments, pounds of P_2O_5/A			
Soil	Foliar	Pounds of seed cotton per acre[1]	Percent harvested at first picking
0	0	2164 c	46
30	0	2404 a	48
60	0	2425 a	55
0	21.7	2407 a	48
0	21.7[2]	2289 b	47
0	13.4[3]	2354 ab	47

c.v.=9.4%

[1] Any two values not followed by the same letter are significantly different from each at odds of 19:1.

[2] Phosphorus was applied as sodium polyphosphate.

[3] Foliar feeding was begun late in the fruiting period.

Table 4. Effect of soil and foliar application of phosphorus on the yield and maturity of cotton at the Central Station on Kaufman Fine Sandy Loam.

Treatment, pounds of P_2O_5/A			
Soil	Foliar	Pounds of seed cotton per acre[1]	Percent harvested at first picking
0	0	2260 a	74
0	14.4	2291 a	78
0	7.0[2]	2174 a	76
120	0	2246 a	75
120	14.4	2275 a	77
120	7.0[2]	2242 a	76

c.v.=9.4%

[1] Any two values not followed by the same letter are significantly different from each other at odds of 19:1.

[2] Foliar feeding was begun late in the fruiting period.

Table 5. Effect of soil and foliar application on the yield and maturity of cotton in the cylinder experiment at the Central Station.

Treatment, grams of P_2O_5/cylinder		Grams of seed cotton per cylinder		Percent harvested	
Soil	Foliar	Total[1]	Increase for foliar feeding	First picking	1st and 2nd picking
0	0	339 f	..	13	63
0	1.6	429 e	90	21	68
2.9	0	579 d	....	49	81
2.9	1.6	648 c	69	49	85
5.8	0	754 a		55	88
5.8	1.6	727 ab	—27	61	91
8.8	0	687 bc	...	66	91
8.8	1.6	682 bc	—5	58	89
11.7	0	652 c	...	52	86
11.7	1.6	653 c	1	62	90
	c.v.=21.7%				

[1] Any two values not followed by the same letter are significantly different from each other at odds of 19:1.

load, is not necessary to obtain maximum yield.

Accordingly, it may logically be concluded that the roots of the cotton plant have the capacity to absorb all the phosphorus needed by the above-ground portion of the plant during stress periods and that levels of soil phosphorus adequate to supply these needs may occur naturally or as a result of proper fertilization practices. Translocation of phosphorus previously accumulated in other plant parts to the developing bolls may reduce the need for absorption of phorphorus by the roots during stress periods to some extent. But, depending on the yield, 50 percent or more of the phosphorus used by cotton is taken up between the time of early boll formation and maturity.

As employed in these experiments, foliar feeding alone did not correct phosphorus deficiency at the Black Belt Branch Station and in the cylinder experiment at the Central Station even though 8 to 10 applications were made. Soil application or a combination of soil and foliar application of phosphorus was required to correct it. Yield increases for foliar application of phosphorus beginning early in the fruiting period at the Pontotoc Ridge-Flatwoods Branch Station were the same as for soil application of phosphorus, but only 30 pounds of P_2O_5 an acre as a soil application was needed to correct phosphorus deficiency at this location.

Although an increase in the yield of cotton was obtained under conditions of phosphorus deficiency, it is apparent from the results just presented that only a slight to moderate deficiency of phosphorus may be corrected by foliar feeding even with repeated application during the fruiting period.

If the phosphorus applied to the leaves had been utilized more efficiently, fewer applications would have been required. For example, in a field where 1000 pounds of seed cotton is produced without phosphorus the above-ground portion of the crop, including the seed cotton, is estimated to contain 14 pounds of P_2O_5 if phosphorus is added to correct the deficiency and the field then produces 2000 pounds of seed cotton per acre the phosphorus in the above-ground portion of the crop would be increased to about 30 pounds of P_2O_5 per acre, or an increase of 16 pounds of P_2O_5 per acre for 1000 pounds of seed cotton. This would give a 63-pound increase in the yield of seed cotton for each pound of P_2O_5 in the above-ground portion of the crop.

If 75 percent of the phosphorus applied

as a foliar spray to cotton were absorbed by the leaves and utilized, then one pound of foliar-applied phosphorus could increase the yield as much as 45 pounds of seed cotton per acre. But efficiency of this magnitude was not obtained in the field experiments.

At the Black Belt Branch Station, the increase for foliar-applied phosphorus was only a little more than 7 pounds of seed cotton per pound of P_2O_5 where no phosphorus was applied to the soil. At the Pontotoc Branch Station the increase for foliar-applied phosphorus was 11 pounds of seed cotton per pound of P_2O_5. In each of these field experiments foliar-applied phosphorus was slightly more efficient than soil-applied phosphorus.

As an average, approximately 1.2 pounds of phosphorus was required to give the same increase when applied to the soil as one pound applied to the leaves during the fruiting period. Both soil-applied and foliar-applied phosphorus apparently was utilized more efficiently in the cylinder experiment than in the field experiments, but here phosphorus applied to the soil was slightly more efficient that that applied to the leaves.

Foliar application of phosphorus during the latter part of the fruiting period at the Central Station did not increase the yield of cotton. However, at the Pontotoc Ridge-Flatwoods Branch Station there was an increase in yield, but the increase was not as large as when application of phosphorus was begun early in the fruiting period.

These results show that phosphorus deficiency of appreciable magnitude is likely to exist throughout the fruiting period, not just late in the season, and that foliar feeding of phosphorus must be started early in the fruiting period and continued thereafter to correct such a deficiency. Phosphorus deficiency which does not develop until late in the fruiting period would be expected to reduce the final yield only slightly but could be corrected by foliar feeding.

Earliness of cotton was affected only slightly by foliar application of phosphorus even under conditions of severe phosphorus deficiency and not at all where application of phosphorus failed to increase the yield of cotton. On the other hand, the effect of soil-applied phosphorus was outstanding, especially in the cylinder experiment. As was the case with foliar-applied phosphorus, soil application did not increase earliness of cotton except where it increased the yield also. If the increase in yield for phosphorus were small, then earliness of the cotton was increased only slightly. If the increase were large, there was a marked increase in earliness.

In the cylinder experiment without phosphorus only 13 percent of the total yield was harvested at the first picking, but with an application of enough phosphorus to the soil for optimum yield 55 percent was harvested. Foliar application alone increased the percentage of the yield harvested at the first picking only 8 percent. That foliar feeding of phosphorus during the fruiting period should have affected the earliness of cotton only slightly seems logical because the factors which affect early boll-set and maturity must exert their influence early in the development of the plant.

Two sources of phosphorus, monoammonium phosphate and sodium polyphosphate were compared for foliar feeding at the Black Belt and Pontotoc Ridge-Flatwoods Branch Stations. At the Black Belt Station the two sources were equally effective, but at the Pontotoc Ridge-Flatwoods Branch Station monoammonium phosphate appeared to be more effective. More work is needed before a definite conclusion can be reached as to which, if either, is better. These sources were chosen because they represent the kinds of phosphate salts generally available for the formulation of liquid fertilizers containing phosphorus.

CONCLUSIONS

Foliar application of phosphorus to cotton frequently during the fruiting period increased the yield where a phosphorus deficiency existed but not beyond what could be obtained with soil application alone. Therefore, foliar feeding in addition to soil application is not required for top yields. Where only slight to moderate phosphorus deficiency existed foliar feeding was effective in correcting it but not if there was a severe to moderately severe deficiency. In such situations soil, or soil plus foliar feeding, was necessary.

Earliness of cotton was markedly increased by soil application of phosphorus where a large increase in yield occurred, but it was not affected where there was no yield increase for phosphorus. Phosphate fertilizers seldom increase the yield of cotton in the Delta Area. Foliar application of phosphorus increased the earliness of cotton only slightly even under conditions of severe phosphorus deficiency and not at all where there was not a yield increased for the application of phosphorus.

Late-season foliar feeding may be employed to correct a slight phosphorus deficiency, but application beginning early in the fruiting periods is necessary to correct even a moderate deficiency.

In the field experiments a pound of phosphorus applied to the leaves gave a slightly higher increase in yield than when applied to the soil, but the reverse was true in the cylinder experiment. A marked increase in the efficiency of phosphorus by foliar application would have provided additional justification for consideration of the practice.

Application of dilute solutions of phosphorus are necessary to avoid injury to the leaves. Solutions containing as little as 1.5% P_2O_5 caused some leaf injury. More concentrated solutions caused even more burning.

In view of these results and those obtained before with nitrogen, foliar of application of the primary (nitrogen, phosphorus, and potassium) and secondary (calcium, sulfur, and magnesium) nutrients to cotton does not appear to be a practical alternative to soil application. Foliar feeding of the micronutrients may be a satisfactory alternative but is not necessary in addition to soil applicaton for top yields.

Additional research may reveal some advantages for foliar feeding not now recognized, but the prospects are not too encouraging.

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Equilibrium Prices and Flows of Broilers in the United States for 1961-63 and 1970

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Acknowledgement

The author is indebted to D. W. Parvin, T. E. Tramel, V. G. Hurt, T. D. Phillips, and L. D. Welch for many valuable comments and suggestions.

Equilibrium Prices and Flows of Broilers in the United States for 1961-63 and 1970

A. D. Seale, Jr.

Introduction

Growth and shifts in population among areas of the United States will result in major shifts in the demand for broilers. The efficiency of the broiler industry will depend upon the extent to which producers and marketing firms adjust their operations to accommodate these shifts in demand.

The purpose of this study was to provide some guidelines for orderly growth and development of the broiler industry.

The objectives of this study were to:

1. Develop supply estimates by areas for a base and for a projected period.
2. Develop demand estimates by areas for the same two periods.
3. Estimate the costs of transporting broilers among areas.
4. Evaluate the equilibrium quantities, flows, and prices of broilers for supply-demand conditions in the base period and in the projected period.

The base period used was an average week in 1961-63; the projected period, a week in 1970. In the selection of a base period from which to measure changes, a three-year period was deemed long enough to average out short-term fluctuations in quantities and prices. All data on prices and cost are expressed in terms of 1961-63 price levels.

All data on supply and demand were reduced to an average week and are expressed in units of 1,000 pounds. Transportation costs were based on truckload rates and are expressed in dollars per 1,000 pounds.

The broiler market for purposes of this study was defined as the area composed of the 48 contiguous states. The market was divided into 42 areas each of which was considered to be a marketing area. Only those areas for which commercial production was reported were considered as producing areas.

The text of this report is confined to a summary of the analysis of the situation for the base period, the projected period, and a comparison of the changes between the two. The information shown as equilibrium levels for consumption, prices and movements is based on conditions of perfect competition. These would be the results if all shippers were to ship to the areas offering the highest net prices. Net prices are defined as the retail price less the cost of transportation. These results were computed by reactive programming [1] procedures which considered the demand for broilers in each area, the supply of broilers in each area and the cost of shipping broilers among areas.

Supplies

The estimated supplies of broilers for each commercial producing area for the base and projected periods and percentage changes are shown in Table 1 (See Appendix for a discussion of estimating procedure). The indicated changes in supplies for the respective areas suggest the type of adjustments that must be made in facilities for assembling and processing broilers. The largest increases in supplies were indicated for Alabama, Arkansas, North Carolina and Mississippi. The largest decreases were indicated for New England, Virginia and Indiana.

---

[1] Tramel, Thomas E. and Seale, A.D., Jr., "Reactive Programming of Supply and Demand Relations - Application to Fresh Vegetables," Journal of Farm Economics, Volume XLI, December, 1959, No. 5, pp. 1012-1022.

Demand

Demand as used in this report includes three basic parts (1) the quantity consumed, (2) the price paid for the quantity consumed and (3) changes in the quantity consumed that result from changes in the price of broilers. These basic parts of demand are usually expressed mathematically and are referred to as demand functions; these are shown in the Appendix.

Total Consumption: Estimates of consumption by states are not available; however, such estimates were needed for the approach used to estimate demand functions. Total weekly consumption estimates by areas for the base period and the equilibrium estimates are shown in Table 2. The magnitude of the differences in the two consumption estimates for the base periods is as small as one could expect from the method of estimation used. (See Appendix for a discussion of estimated procedure).

The changes in the equilibrium consumption levels indicate the nature of the adjustment needed for the efficient handling of broilers at the wholesale and retail levels. The largest increases in consumption are indicated for California, New York and Michigan. The largest decreases are indicated for Arkansas, Oklahoma, and Mississippi.

Total broiler consumption for the United States is expected to increase at about the same rate as total population. Per capita consumption estimates for the base period were developed from the Household Consumer Survey data and were adjusted to the 1961-63 U.S. average level. Equilibrium consumption levels per person by areas are shown in Table 3.

Intra- and Inter-Area Shipments and Net Prices

The volumes consumed within the producing areas are referred to as intra-area shipments and the volumes shipped among areas are referred to as inter-area shipments. The shipments shown are those that would have resulted if all producing areas had shipped to the market areas offering the highest net prices under equilibrium conditions.

For the base period, intra-area shipments were indicated for each of the 36 commercial producing areas while inter-area shipments were indicated for only eight areas. The intra- and inter-area shipments for the 1961-63 base week are shown in Table 4. The average net prices for the equilibrium shipments to the market areas specified in Table 4 are shown in Table 5. In addition the net prices in the best three alternative market areas for each producing area are also shown in Table 5. The net prices in the alternative markets may be used as a guide for selecting the most profitable outlets if production in a particular area should be expanded since each of the best alternative market areas are deficit supply areas.

For the projected period, there were 22 commercial producing areas and intra-area shipments were indicated for each while inter-area shipments were indicated for only seven areas. The intra- and inter-area shipments for the 1970 projected week are shown in Table 6. The average net prices for the equilibrium shipments to the markets specified in Table 6 are shown in Table 7. The three best alternative markets and the respective net prices are also shown in Table 7.

Changes in the supply-demand situation from the base period to the projected period will result in considerable changes in the inter-area shipments. Consequently, major adjustments in the facilities for handling long distance shipments will be required if such shipments are to be handled efficiently.

The only deficit area during the base period that is expected to become an excess producing area by 1970 was Tennessee. Production in Texas and West Virginia was in excess of consumption during the base period but these areas are expected to become deficit by 1970. The largest increases in shipments into areas are indicated for New England, California, and New York. The largest decreases in the shipments into areas are indicated for Tennessee, Minnesota, and Idaho. The largest increases in shipments out of the area are indicated for Alabama, Arkansas, and North Carolina. The largest decreases in shipments out of the area are indicated for Texas, Delaware-Maryland and West Virginia (Table 8).

Retail Prices

There were considerable differences between the average of the reported retail prices and the equilibrium retail prices for the base period. Differences in the reported retail prices among areas appear to be out of line in that they cannot be explained by cost of transportation. For example, the reported price for New York exceeded the reported price for New Jersey by 2.3 cents per pound while the equilibrium price for New York exceeded the New Jersey price by only one-tenth cent per pound. As a result of using a constant price level and the demand and supply projections, there is little difference in the equilibrium price levels for the base and projected periods. The average of the reported retail prices and equilibrium retail prices in cents per pound are shown by areas in Table 9.

Excess-Deficit Supplies, Prices and Flows, 1961-63

The excess supplies of broilers are concentrated in the Southeastern region of the U.S. In 1961-63 the heaviest concentration of excess supplies was in Georgia, Arkansas, Delaware-Maryland, Alabama, North Carolina and Mississippi. The excess and deficit supplies for 1961-63 are shown, by areas, in Figure 1.

Equilibrium prices are closely related to the excess-deficit supply situations. In general, higher prices are associated with deficit supply areas and lower prices are associated with excess supply areas. The equilibrium price for the more remote deficit areas of Washington, Oregon and California was 40 cents or more per pound. The equilibrium prices in the major excess areas were 37-38 cents per pound. The equilibrium price surface for 1961-63 is shown in Figure 2.

The flows of broilers from excess areas to deficit areas are also closely related to prices. As would be expected, the equilibrium flows are from low-price, excess areas to the higher price, deficit areas. The equilibrium flows for 1961-63 are shown in Figure 3.

Excess-Deficit Supplies, Prices and Flows, 1970

The major change in the excess-deficit situation from the base period to 1970 is that most of the deficit areas will become more deficit and considerable increases in excess supplies are expected for most of the major producing areas. The excess-deficit supply situation, by areas, for 1970 is shown in Figure 4.

The retail price surface for 1970 is very similar to the price surface shown for the base period. Prices of about 40 cents per pound are indicated for the areas along the West Coast while prices for the excess producing areas of the South are expected to be about 37-38 cents per pound. The equilibrium price surface is shown in Figure 5.

The equilibrium flows of broilers for 1970 are expected to follow patterns very similar to that shown for the base period. The major change in the equilibrium flows are expected to be in terms of the volumes moved rather than changes in the direction of flows. The equilibrium flows are shown in Figure 6.

Limitations and Implications

Any conclusion drawn from this study with respect to prices and cost will be in terms of 1961-63 dollars. Cost for assembling and distributing broilers within the respective areas were considered as a constant which applied to all areas. Therefore inferences can be drawn with respect to wholesale and farm prices because they would follow the same pattern as retail prices, but at lower levels. Results for 1970 are based on projected supply and demand conditions.

No changes in per capita consumption were predicted for the period 1961-63-1970. However, population is expected to increase by 15 percent and as a result the total quantity of broilers demanded and produced are expected to increase about 15 percent.

From a careful study of the results shown in this report one may well conclude that technological developments in the transportation industry have virtually eliminated the transportation cost advantages of location for the broiler industry. The future location of the broiler industry will be highly dependent upon the technology employed in production and the corresponding cost. Transportation cost will likely continue to exert a smaller and smaller influence on the location of broiler production.

Some specific conclusions may be drawn for each of the specified areas as illustrated for Mississippi. For the period under consideration, supplies in Mississippi are expected to increase almost five million pounds per week or by 73 percent and quantities demanded or consumed are expected to decrease about nine percent. (Some of the more recent population estimates for Mississippi indicate a slight increase in population for 1970. If these more recent trends continue, there will be a slight increase in consumption in Mississippi). Weekly supplies exceeded consumption during the base period by more than five million pounds and the excess production is expected to increase to more than 10 million pounds per week by 1970. The best outlets during the base period were Arizona, California, Louisiana and New Mexico. These areas in addition to Texas and Illinois are expected to be the best outlets during 1970. The best three alternative markets for Mississippi produced broilers during the base period were Nevada, Oklahoma, and Missouri. The best three alternative outlets indicated for the projected period are Oklahoma, Wisconsin and Nevada.

In terms of the 1961-63 price levels, no significant changes in prices at the retail, wholesale or farm level are anticipated. Thus revenue to the broiler industry of Mississippi is expected to increase in proportion to the quantity produced or an increase of about 73 percent.

Supplies for 1961-63

The weekly supply of broilers for consumption available in each area during the base period was obtained by averaging the pounds of live weight produced annually in the years 1961-63. Average annual production was reduced to an average week and then adjusted by a dressing percentage of 72.4 percent to obtain the supply available for consumption for an average week during the base period.

Supplies for 1970

Supply estimates for 1970 were obtained by projecting the supply trends within each of the producing areas.

Production trends were estimated by regression procedures for the period 1946-63, and for 1954-63 using percent of U.S. production as the dependent variable and year as the independent variable. The independent variable was coded so that 1946 had a value of one and 1963 had a value of 18. Each series of data for each area was evaluated by fitting the following equation:

$$\text{Percent of U.S. Production} = a + b\ (\text{year})$$

The constants from the regression analysis from each series for each area were used to predict the percent of U.S. production in each area for 1963. Negative predictions for individual areas were set equal to zero and the remaining estimates for individual areas were summed. The sum of the area estimates from each series added to 100; therefore each series resulted in satisfactory prediction equations; however, estimates based on the 1954-63 series yielded estimates for individual areas for 1963 that generally were closer to reported production than were the estimates based on the 1946-63 series. Consequently, the estimates based on the 1954-63 series was used to estimate the percent of U.S. production to be assigned to individual producing areas. The percentage estimates for 1970 were developed by using the coded value of 25 for 1970 for the independent variable in the prediction equation and setting all negative estimates to zero and adjusting the remaining positive estimates so that the sum was equal to 100 percent. Total U.S. production was set equal to the projected demand based on projected population changes and a constant level of per capita consumption. The prediction equations and projected supplies are shown in Appendix Table 3.

Demand 1961-63

Consumption: The average total supply of dressed broilers produced during the base period (1961-63) was divided by the average population of the U.S. yielding a per capita consumption estimate of 26.17 pounds per year or one-half pound per week. Regional per capital consumption indices were developed from the 1955 USDA Household Food Consumption Survey [1] for the purpose of developing consumption estimates for each area in 1961-63.

Prices and Demand Functions: Prices paid for broilers in retail stores in March, June, September and December for the period 1961-63 were averaged to obtain an estimate of the average annual price per pound in each consuming area. Prices per pound were converted to price per 1000 pounds. The price flexibility estimate used in this study was -.95 as reported by Brandow. [2]

The estimates of prices, consumption, and price flexibility for each consuming area were used to develop a demand function of the following form:

$$(1)\ \log_e \text{price} = A + (-.95)\ (\log_e \text{quantity}).$$

Since A was the only unknown for each area, the equations could be readily solved. The A values for the demand equations are shown in Appendix Table 2.

---

[1] USDA Household Food Consumption Survey, 1955, Reports Nos. 1-5.

[2] Brandow, G. E., Interrelations Among Demands for Farm Products and Implications for Control of Market Supply. The Pennsylvania State University, Agricultural Experiment Station Bulletin, No. 680, p. 32, August 1961.

Demand for 1970

The 1961-63 equilibrium quantity for each area was adjusted in proportion to the projected changes in population for each area from 1961-63 to 1970. The population estimates for 1970 as projected by the Bureau of the Census was adjusted upward by 1.7 percent (Appendix Table 1). This adjustment in the projected population was developed through consultation with the Department of Sociology of Mississippi State University. The quantities obtained were considered as estimates of the quantity that would be purchased in each area in 1970 at the 1961-63 equilibrium prices. The price flexibility of -.95 was then used in conjunction with these estimates of prices and quantities to solve for the $\underline{A}$ value for the price equation for each area. The $\underline{A}$ values for the price equations are shown in Table 2.

Transportation Cost

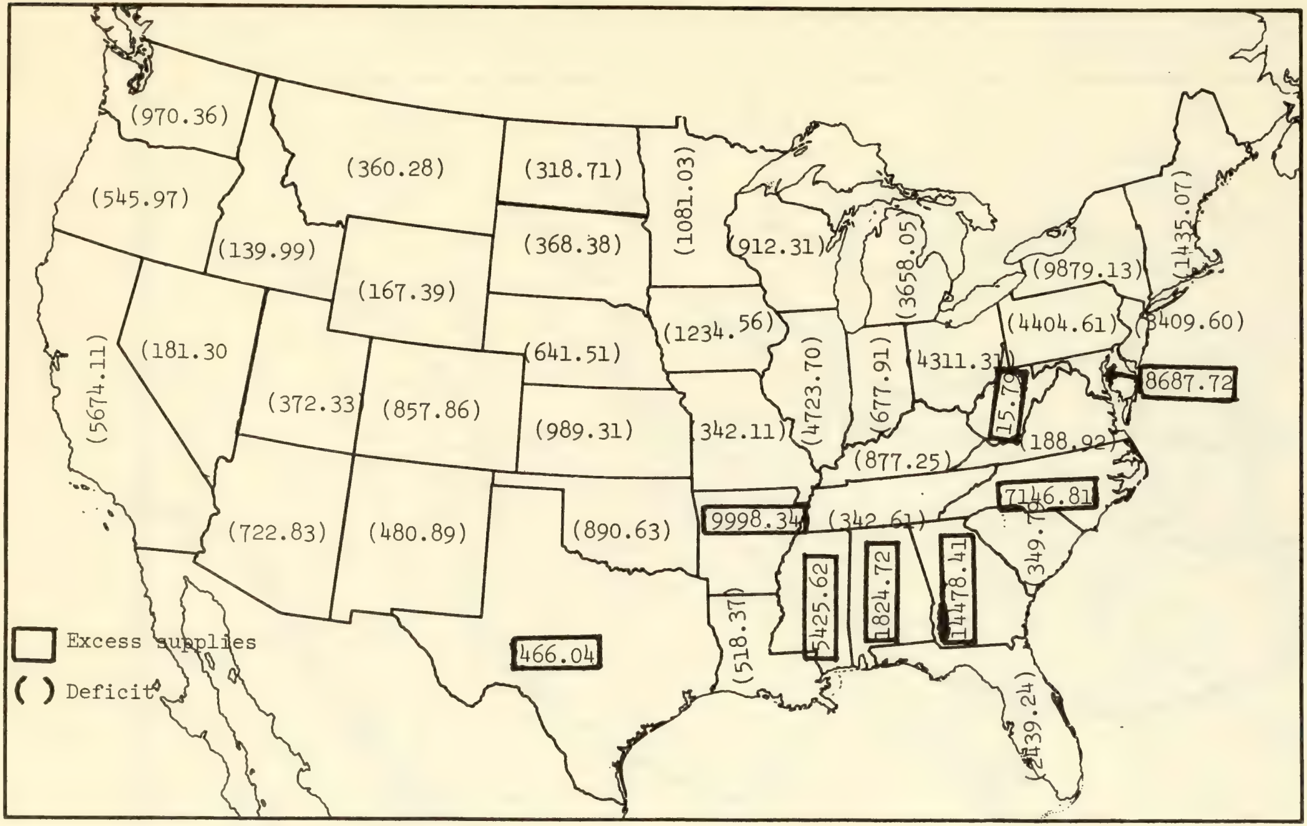
Transportation costs from each producing area to each consuming area were developed from data provided by a commercial transportation firm. 3/ Usual regression procedures were used to estimate the effect of air miles on reported charges between specified points. The following equation was developed:

$$\text{Dollars per 1,000 pounds} = 13.88290 + (.0102557)\ (\text{air miles})$$

This equation was used to develop a complete set of cost data among the producing and consuming areas. The central points used to compute air mileages from each producing area to each consuming area are shown in Appendix Table 4.

3/ Rigg Dairy Express, Inc., Commodity Rates, Versailles, Ohio, January 21, 1961.

APPENDIX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(167.39)
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(877.25)
188.92
7146.81
(722.83)
(480.89)
(890.63)
9998.34
(342.61)
349.79
466.04
(518.37)
5425.62
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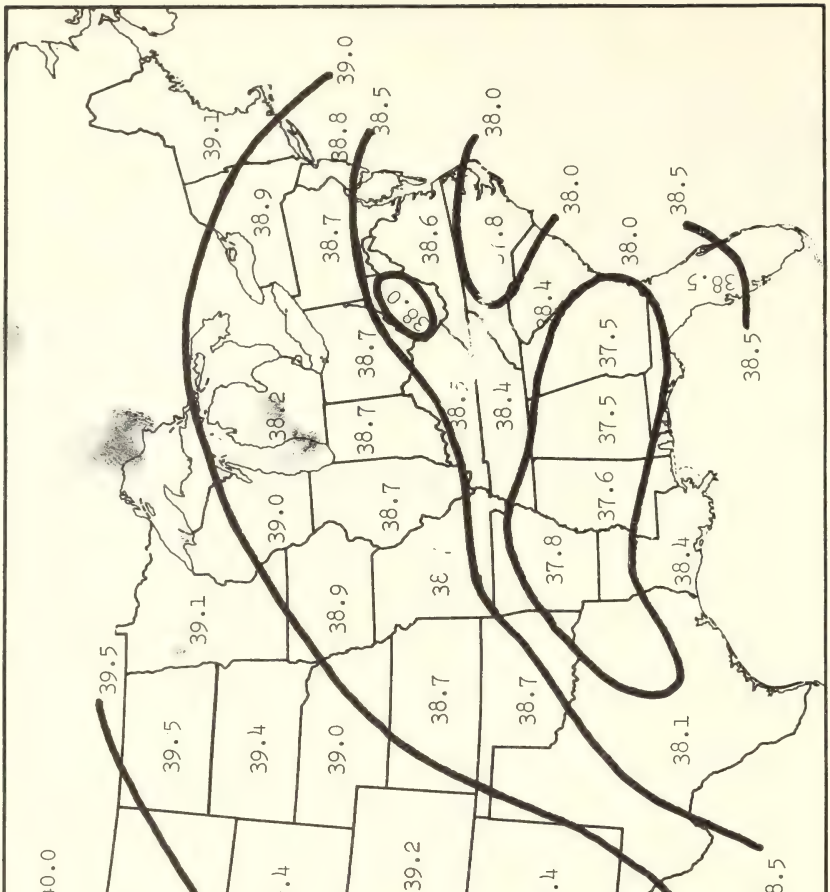
14478.41
(2439.24)
Excess supplies
( ) Deficit

Figure 1. Excess and deficit supplies of broilers in thousands of pounds average week 1961-63.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40.2
40.0
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39.7
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39.4
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39.5
39.1
39.0
39.0
39.2
39.4
39.0
38.9
38.7
38.7
38.5
38.9
38.7
38.7
38.2
39.1
38.9
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37.5
37.5
38.4
38.1
38.0
38.0
38.0
38.5
38.5
38.5
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39.0
39.0
39.5
39.5
40.0

Figure 2. Equilibrium market prices for broilers in cents per pound average week 1961-63.

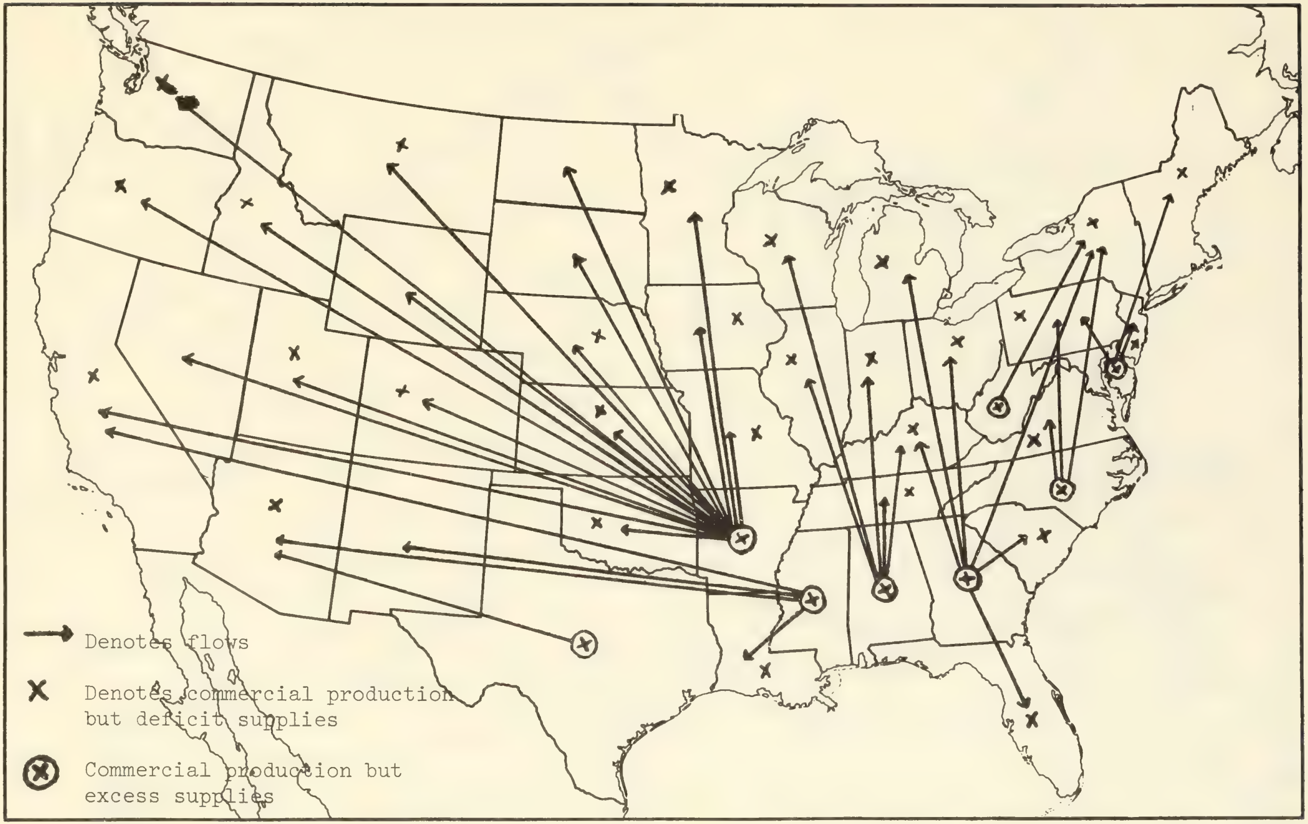
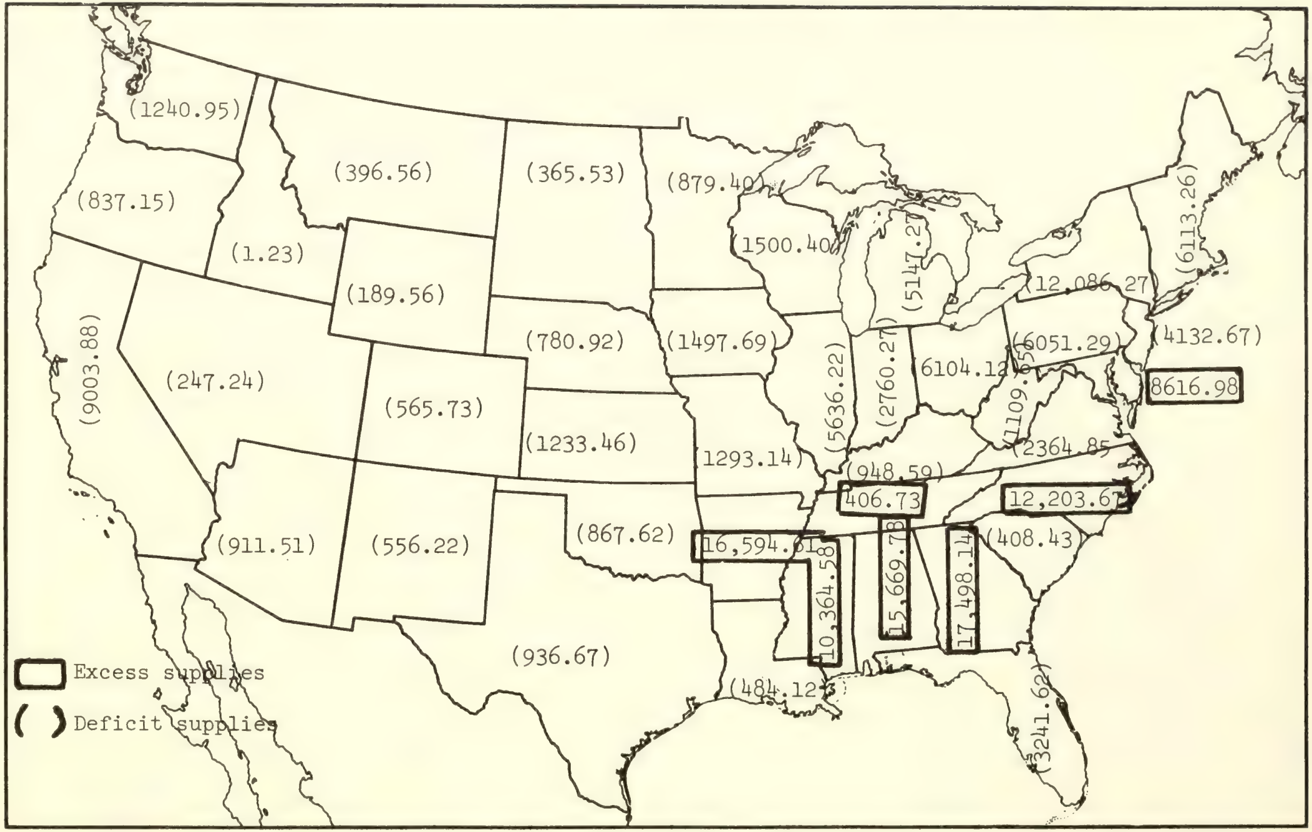

Denotes flows
Denotes commercial production but deficit supplies
Commercial production but excess supplies

Figure 3. Equilibrium flow of broilers for average week 1961-63.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(1.23)
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(6113.26)
(12,086.27)
(189.56)
(1497.69)
(9003.88)
(780.92)
(4132.67)
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(247.24)
(5636.22)
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1293.14
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17,498.14
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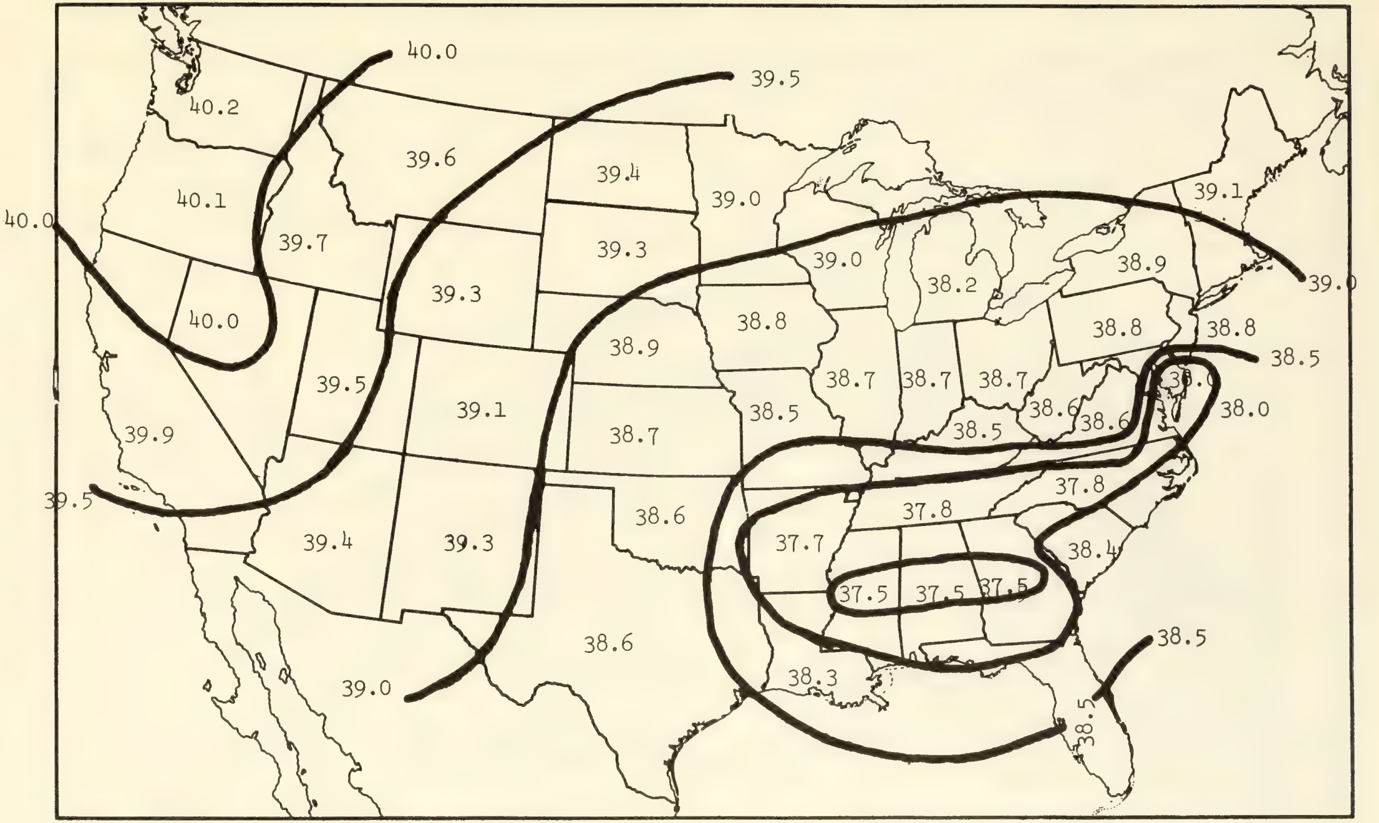
(3241.62)
Excess supplies
( ) Deficit supplies

Figure 4. Excess and deficit supplies of broilers per week in thousands of pounds - 1970 projection.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38.9
40.0
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38.4
39.4
39.3
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38.5

Figure 5. Equilibrium retail prices for broilers in cents per pound - projection for 1970.

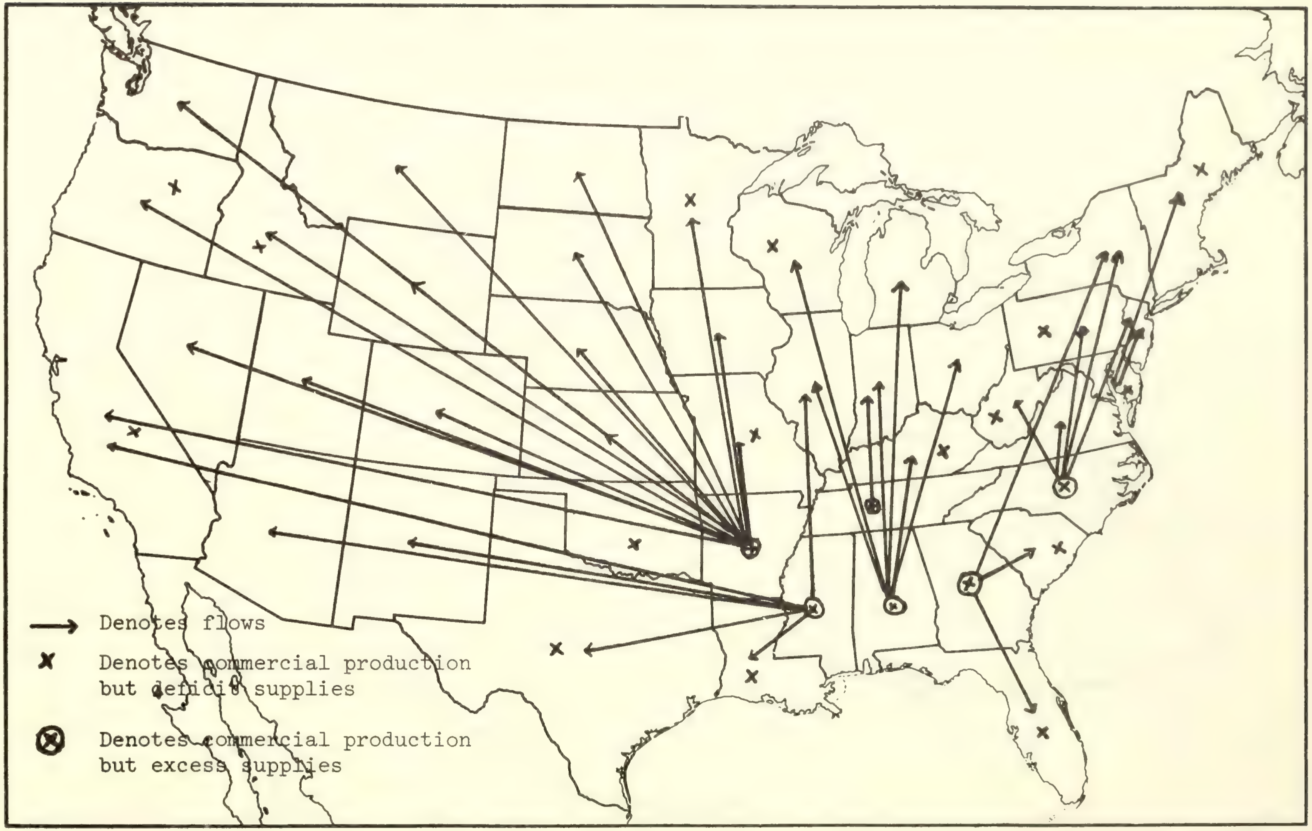
Denotes flows
Denotes commercial production but deficit supplies
Denotes commercial production but excess supplies

Figure 6. Equilibrium flows of broilers for 1970.

Table 1. Estimated weekly supplies of broilers, U. S. market-supply area, 1961-63 average and projected 1970.

Area	Supplies		Changes	
	1961-63	1970	Amount	Percent
	1,000 lbs			
1. Alabama	10,010.9	17,447.21	7,436.31	74.3
2. Arizona	14.8	0	- 14.8	-100.0
3. Arkansas	10,985.2	17,390.93	6,405.73	58.3
4. California	3,096.7	1,763.23	- 1,333.47	- 43.1
5. Colorado	24.1	0	- 24.1	-100.0
6. Del. Md. D.C.	11,211.1	11,841.59	630.49	5.6
7. Florida	487.9	22.51	- 465.39	- 95.4
8. Georgia	16,581.3	19,732.24	3,150.94	19.0
9. Idaho	218.0	371.46	153.46	70.4
10. Illinois	171.6	0	- 171.6	-100.0
11. Indiana	1,526.1	0	- 1,526.1	-100.0
12. Iowa	170.4	0	- 170.4	-100.0
13. Kansas	73.0	0	- 73.0	-100.0
14. Kentucky	716.2	731.66	15.46	2.2
15. Louisiana	1,183.5	1,440.80	257.30	21.7
16. Michigan	186.1	0	- 186.1	-100.0
17. Minn.	586.6	1,024.32	437.72	74.6
18. Miss.	6,612.6	11,447.62	4,835.02	73.1
19. Missouri	1,697.2	1,114.37	- 582.83	- 34.3
20. Montana	-	-	-	-
21. Nebraska	55.8	0	- 55.8	-100.0
22. Nevada	-	-	-	-
23. New England	4,950.3	754.17	- 4,196.13	- 84.8
24. New Jersey	266.7	0	- 266.7	-100.0
25. New Mexico	-	-	-	-
26. New York	383.5	0	- 383.5	-100.0
27. N.C.	9,540.2	14,892.04	5,351.84	56.1
28. N.D.	-	-	-	-
29. Ohio	570.2	0	- 570.2	-100.0
30. Okla.	394.3	270.15	- 124.15	- 31.5
31. Oregon	476.0	495.28	19.28	4.1
32. Penn.	2,065.3	1,226.93	- 838.37	- 40.6
33. S. C.	941.4	1,114.37	172.97	18.4
34. S. D.	-	-	-	-
35. Tenn.	1,614.5	2,577.68	963.18	59.7
36. Texas	5,817.4	5,346.73	- 470.67	- 8.1
37. Utah	88.0	0	- 88.0	-100.0
38. Va.	2,046.4	0	- 2,046.4	-100.0
39. Wash.	820.3	877.99	57.69	7.0
40. West Va.	991.4	0	- 991.4	-100.0
41. Wis.	946.0	675.38	- 270.62	- 28.6
42. Wyoming	-	-	-	-
Total	97,521.0	112,562.66		

Table 2. Estimates of weekly consumption of broilers, by areas, 1961-63 average and projected 1970.

Area	Original estimate 1961-63[1]	Equilibrium estimate[2]		Changes	
		1961-63	1970	Amount	Percent
	1,000 lbs.				
1. Alabama	1,861.5	1,762.18	1,777.44	15.24	.9
2. Arizona	693.9	737.63	911.51	173.88	23.6
3. Arkansas	1,025.7	986.86	796.32	-190.54	- 19.3
4. California	7,912.6	8,770.81	10,771.13	2,000.32	22.8
5. Colorado	883.5	881.96	1,046.26	164.30	18.6
6. Del. Md. D.C.	2,504.3	2,523.38	3,224.61	701.23	27.8
7. Florida	3,043.9	2,927.14	3,264.12	336.98	11.5
8. Georgia	2,284.0	2,102.89	2,243.10	140.21	6.7
9. Idaho	325.5	357.99	372.69	14.70	4.1
10. Illinois	4,989.6	4,895.30	5,637.22	741.92	15.2
11. Indiana	2,308.3	2,204.01	2,760.27	556.26	25.2
12. Iowa	1,367.5	1,404.96	1,497.69	92.73	6.6
13. Kansas	1,090.0	1,062.31	1,233.46	171.15	16.1
14. Kentucky	1,722.0	1,593.45	1,680.25	86.80	5.4
15. Louisiana	1,876.4	1,701.87	1,924.92	223.05	13.1
16. Michigan	3,956.0	3,844.15	5,147.27	1,303.12	33.9
17. Minn.	1,710.1	1,667.63	1,903.72	236.09	14.2
18. Miss.	1,261.4	1,186.98	1,083.04	-103.94	- 8.8
19. Missouri	2,130.7	2,039.31	2,407.51	368.20	18.1
20. Montana	326.4	360.28	396.56	36.28	10.1
21. Nebraska	717.7	697.31	780.92	83.61	12.0
22. Nevada	160.6	181.30	247.24	65.94	36.4
23. New England	6,050.7	6,385.37	6,867.43	482.06	7.5
24. New Jersey	3,589.6	3,676.30	4,132.67	456.37	12.4
25. New Mexico	466.0	480.89	556.22	75.33	15.7
26. New York	9,905.9	10,262.63	12,086.27	1,823.64	17.8
27. N. C.	2,631.8	2,393.39	2,688.37	294.98	12.3
28. N. D.	312.9	318.71	365.53	46.82	14.7
29. Ohio	4,952.2	4,881.51	6,104.12	1,222.61	25.0
30. Okla.	1,366.7	1,284.93	1,137.77	-147.16	- 11.5
31. Oregon	848.2	1,021.97	1,332.43	310.46	30.4
32. Penn.	6,460.2	6,469.91	7,278.22	808.31	12.5
33. S. C.	1,369.1	1,291.19	1,522.79	231.60	17.9
34. S. D.	355.7	368.38	404.74	36.36	9.8
35. Tenn.	2,040.6	1,957.11	2,170.95	213.84	10.9
36. Texas	5,660.0	5,351.36	6,283.40	932.04	17.4
37. Utah	446.7	460.33	565.73	105.40	22.9
38. Va.	2,363.1	2,235.32	2,364.84	129.52	5.8
39. Wash.	1,397.5	1,790.66	2,118.94	328.28	18.3
40. West Va.	1,002.5	975.61	1,109.65	134.04	13.7
41. Wis.	1,991.3	1,858.31	2,175.78	317.47	17.1
42. Wyoming	158.7	167.39	189.56	22.17	13.2
Total	97,521.0	97,521.0	112,562.66		

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[1] Average U.S. per capita consumption adjusted by index developed from USDA, 1955, Household Consumer Survey, multiplied by the population in each area.

[2] Results from reactive programming analysis.

Table 3. Estimates of weekly per capita consumption of broilers, 1961-63 average and projected 1970 by areas.

Area	Equilibrium estimates[1/]	
	1961-63	1970
	pounds	
1. Alabama	.53	.53
2. Arizona	.49	.50
3. Arkansas	.54	.54
4. California	.52	.52
5. Colorado	.46	.47
6. Del. Md. D.C.	.56	.56
7. Florida	.54	.54
8. Georgia	.51	.51
9. Idaho	.51	.51
10. Illinois	.48	.48
11. Indiana	.47	.47
12. Iowa	.51	.51
13. Kansas	.48	.48
14. Kentucky	.52	.52
15. Louisiana	.51	.51
16. Michigan	.48	.48
17. Minn.	.48	.48
18. Miss.	.53	.53
19. Missouri	.47	.47
20. Montana	.51	.52
21. Nebraska	48	.48
22. Nevada	53	.53
23. New England	.60	.60
24. New Jersey	.58	.58
25. New Mexico	.48	.48
26. New York	.59	.59
27. N. C.	.51	.51
28. N. D.	.50	.50
29. Ohio	.49	.49
30. Okla.	.53	.53
31. Oregon	.56	.56
32. Penn.	.57	.57
33. S. C.	.53	.53
34. S. D.	.51	.51
35. Tenn.	.54	.55
36. Texas	.53	.52
37. Utah	.48	.48
38. Va.	.53	.53
39. Wash.	.60	.60
40. West Va.	.54	.53
41. Wis.	.46	.46
42. Wyoming	.49	.49

1/ Reactive programming results converted to per capita estimates.

Table 4. Intra-and inter-area equilibrium shipment of broilers for average week in 1961-63.

Area	Intra-area shipments	Inter-area shipments[1]	Individual inter-area shipments[2]
	1,000 lbs		
1. Alabama	1,762.18	8,248.72	(10) 4,723.70 (11) 677.91 (14) 624.24 (17) 967.93 (35) 342.62 (41) 912.32
2. Arizona	14.80	-722.83	
3. Arkansas	986.86	9,998.34	(4) 1,504.54 (5) 857.86 (9) 139.99 (12) 1,234.56 (13) 989.31 (17) 113.11 (19) 342.11 (20) 360.28 (21) 641.51 (22) 181.30 (28) 318.71 (30) 890.63 (31) 545.97 (34) 368.38 (37) 372.33 39) 970.36 (42) 167.39
4. California	3,096.70	-5,674.11	
5. Colorado	24.10	-857.86	
6. Del. Md. D.C.	2,523.38	8,687.72	(23) 1,435.07 (24) 3,409.60 (32) 3,843.05
7. Florida	487.9	-2,439.24	
8. Georgia	2,102.89	14,478.41	(7) 2,439.24 (14) 253.01 (16) 3,658.05 (26) 3,467.01 (29) 4,311.31 (33) 349.79
9. Idaho	218.00	-139.99	
10. Illinois	171.60	-4,723.70	
11. Indiana	1,526.10	-677.91	
12. Iowa	170.40	-1,234.56	
13. Kansas	73.00	-989.31	
14. Kentucky	716.20	-877.25	
15. Louisiana	1,183.50	-518.37	
16. Michigan	186.10	-3,658.05	
17. Minn.	586.60	-1,081.03	
18. Miss.	1,186.98	5,425.62	(2) 256.79 (4) 4,169.57 (15) 518.37 (25) 480.89
19. Missouri	1,697.20	-342.11	
20. Montana	-	-360.28	
21. Nebraska	55.80	-641.51	
22. Nevada	-	-181.30	
23. New England	4,950.30	-1,435.07	
24. New Jersey	266.70	-3,409.60	
25. New Mexico	-	-480.89	
26. New York	383.50	-9.879.13	
27. N. C.	2,393.39	7,146.81	(26) 6,396.33 (32) 561.56 (38) 188.92
28. N. D.	-	-318.71	
29. Ohio	570.20	-4,311.31	
30. Okla.	394.30	-890.63	
31. Oregon	476.00	-545.97	
32. Penn.	2,065.30	-4,404.61	
33. S. C.	941.40	-349.79	
34. S. D.	-	-368.38	
35. Tenn.	1,614.50	-342.61	
36. Texas	5,351.36	466.04	(2) 466.04
37. Utah	88.00	-372.33	
38. Va.	2,046.40	-188.92	
39. Wash.	820.30	-970.36	
40. West Va.	975.61	15.79	(26) 15.79
41. Wis.	946.00	-912.31	
42. Wyoming	-	-167.39	

1/ Positive figures denote shipments from the specified area and negative figures denote shipments into the specified area.

2/ Figures in parentheses denote the receiving area and the corresponding figure denotes the volume.

Table 5. Average net prices per 1,000 pounds for equilibrium shipments and net prices for three best alternative markets for average week 1961-63.

Area	Average of net prices[1]	Net prices in the three best alternative markets[2]		
	- - - - - - -	- - - - - - - dollars per 1,000 pounds	- - - - - - -	- - - - - - -
1. Alabama	375.05	(29) 374.88	(16) 374.83	(19) 374.82
2. Arizona	395.37	(4) 388.08	(22) 386.37	(25) 385.20
3. Arkansas	377.59	(25) 377.61	(41) 376.73	(10) 376.48
4. California	399.90	(31) 389.64	(22) 389.50	(39) 388.17
5. Colorado	391.65	(37) 385.28	(22) 385.23	(9) 385.20
6. Del. Md. D.C.	380.28	(26) 379.21	(38) 378.23	(29) 376.67
7. Florida	385.05	(33) 373.32	(24) 372.43	(26) 372.36
8. Georgia	375.32	(11) 375.11	(41) 374.96	(35) 374.87
9. Idaho	397.41	(31) 390.97	(39) 390.55	(22) 389.41
10. Illinois	386.95	(17) 380.60	(41) 380.55	(12) 379.77
11. Indiana	386.61	(41) 380.03	(29) 379.62	(17) 379.62
12. Iowa	388.89	(17) 382.42	(34) 382.05	(28) 381.65
13. Kansas	387.35	(20) 381.01	(28) 380.93	(21) 380.91
14. Kentucky	385.38	(29) 378.84	(11) 378.65	(41) 378.46
15. Louisiana	384.01	(2) 377.34	(4) 377.05	(25) 377.04
16. Michigan	382.27	(14) 375.41	(29) 375.29	(11) 375.19
17. Minn.	391.23	(34) 383.36	(20) 382.41	(28) 382.11
18. Miss.	376.07	(22) 375.79	(30) 375.79	(19) 375.79
19. Missouri	386.78	(17) 380.30	(12) 380.29	(34) 379.96
20. Montana	-	-	-	-
21. Nebraska	389.52	(28) 383.10	(34) 383.10	(20) 382.97
22. Nevada	-	-	-	-
23. New England	390.51	(24) 379.19	(26) 377.66	(32) 377.57
24. New Jersey	388.10	(23) 381.60	(32) 379.66	(26) 378.62
25. New Mexico	-	-	-	-
26. New York	388.71	(23) 379.45	(41) 378.73	(32) 378.51
27. N. C.	377.57	(24) 377.29	(23) 377.22	(29) 376.83
28. N. D.	-	-	-	-
29. Ohio	387.25	(26) 379.93	(41) 379.83	(17) 379.22
30. Okla.	387.03	(4) 380.75	(25) 380.70	(22) 380.63
31. Oregon	402.11	(39) 394.01	(4) 387.43	(22) 386.98
32. Penn.	387.45	(23) 380.63	(24) 380.32	(26) 379.77
33. S. C.	383.78	(26) 376.41	(38) 376.32	(32) 376.29
34. S. D.	-	-	-	-
35. Tenn.	383.94	(41) 377.50	(11) 377.46	(17) 377.42
36. Texas	380.77	(4) 380.35	(25) 380.29	(22) 379.75
37. Utah	395.55	(22) 388.99	(31) 388.88	(9) 388.81
38. Va.	385.85	(32) 379.42	(26) 379.11	(23) 379.05
39. Wash.	402.20	(31) 393.93	(4) 385.82	(9) 385.76
40. West Va.	379.68	(32) 379.16	(23) 378.74	(38) 378.61
41. Wis.	389.77	(17) 382.73	(34) 381.24	(20) 380.29
42. Wyoming	-	-	-	-

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[1] Average of net prices for markets to which shipments were made as shown in Table 4.

[2] Figures in parenthesis denote the area and the corresponding figure denotes net price.

Table 6. Intra- and inter-area equilibrium shipments of broilers for 1970 projected week.

Area	Intra-area shipment	Inter-area shipment1/	Individual inter-area shipment2/
	1,000 lbs		
1. Alabama	1,777.44	15,669.77	(10) 2,417.63 (11) 2,353.54 (14) 948.59 (16) 2,345.49 (29) 6,104.12 (41) 1,500.40
2. Arizona		-911.51	
3. Arkansas	796.32	16,594.61	(4) 4,747.43 (5) 1,046.26 (9) 1.23 (12) 1,497.69 (13) 1,233.46 (17) 879.40 (19) 1,293.14 (20) 396.56 (21) 780.92 (22) 247.24 (28) 365.53 (30) 867.62 (31) 837.15 (34) 404.74 (37) 565.73 (39) 1,240.95 (42) 189.56
4. California	1,767.23	-9,003.90	
5. Colorado		-1,046.26	
6. Del. Md. D.C.	3,224.61	8,616.98	(23) 6,113.26 (24) 2,503.72
7. Florida	22.51	-3,241.61	
8. Georgia	2,243.10	17,489.14	(7) 3,241.61 (16) 2,801.78 (26) 11,037.33 (33) 408.42
9. Idaho	371.46	-1.23	
10. Illinois		-5,637.22	
11. Indiana		-2,760.27	
12. Iowa		-1,497.69	
13. Kansas		-1,233.46	
14. Kentucky	731.66	-948.59	
15. Louisiana	1,440.80	-484.12	
16. Michigan		-5,147.27	
17. Minn.	1,024.32	-879.40	
18. Miss.	1,083.04	10,364.58	(2) 911.51 (4) 4,256.47 (10) 3,219.59 (15) 484.12 (25) 556.22 (36) 936.67
19. Missouri	1,114.37	-1,293.14	
20. Montana		-396.56	
21. Nebraska		-780.92	
22. Nevada		-247.24	
23. New England	754.17	-6,113.26	
24. New Jersey		-4,132.67	
25. New Mexico		-556.22	
26. New York		-12,086.27	
27. N. C.	2,688.37	12,203.67	(24) 1,628.95 (26) 1,048.94 (32) 6,051.2 (38) 2,364.84 (40) 1,109.65
28. N. D.		-365.53	
29. Ohio		-6,104.12	
30. Okla.	270.15	-867.62	
31. Oregon	495.28	-837.15	
32. Penn.	1,226.93	-6,051.29	
33. S. C.	1,144.37	-408.42	
34. S. D.		-404.74	
35. Tenn.	2,170.95	406.73	(11) 406.73
36. Texas	5,346.73	-936.67	
37. Utah		-565.73	
38. Va.		-2,364.84	
39. Wash.	877.99	-1,240.95	
40. West Va.		-1,190.65	
41. Wis.	675.38	-1,500.40	
42. Wyoming		-189.56	

1/ Positive figures denote shipments from the specified area and negative figures denote shipments into the specified areas.

2/ Figures in parenthesis denote areas and the corresponding figure denotes volume.

Table 7. Average net prices per 1000 pounds of broilers for equilibrium shipments and net prices for the three best alternative markets for 1970 projected week.

Area	Average of net prices[1]	Net prices in three best alternative markets[2]
	-dollars per 1,000 lbs-	
1. Alabama	374.91	(7) 374.66 (17) 374.39 (26) 374.37
2. Arizona		
3. Arkansas	376.82	(25) 376.65 (41) 376.57 (10) 376.38
4. California	399.02	(31) 388.92 (22) 388.74 (39) 387.43
5. Colorado		
6. Del. Md. D.C.	380.44	(32) 380.44 (26) 379.21 (38) 378.23
7. Florida	385.09	(33) 373.37 (24) 372.71 (23) 372.47
8. Georgia	375.33	(29) 375.36 (14) 375.27 (11) 375.12
9. Idaho	396.66	(31) 390.25 (39) 389.86 (22) 388.64
10. Illinois		
11. Indiana		
12. Iowa		
13. Kansas		
14. Kentucky	385.25	(29) 378.87 (11) 378.66 (41) 378.30
15. Louisiana	382.95	(36) 376.39 (2) 376.27 (4) 376.16
16. Michigan		
17. Minn.	390.49	(34) 382.59 (20) 381.66 (28) 381.37
18. Miss.	375.06	(30) 375.06 (41) 375.02 (22) 375.02
19. Missouri	385.96	(17) 379.56 (12) 379.50 (41) 379.21
20. Montana		
21. Nebraska		
22. Nevada		
23. New England	390.66	(24) 379.47 (32) 377.67 (26) 377.66
24. New Jersey		
25. New Mexico		
26. New York		
27. N. C.	377.60	(23) 377.37 (29) 376.85 (33) 376.18
28. N. D.		
29. Ohio		
30. Okla.	386.31	(4) 379.87 (22) 379.87 (37) 379.80
31. Oregon	401.39	(39) 393.32 (4) 386.55 (22) 386.21
32. Penn.	387.54	(23) 380.78 (24) 380.60 (26) 379.78
33. S. C.	383.82	(24) 376.42 (40) 376.42 (26) 376.41
34. S. D.		
35. Tenn.	377.50	(41) 377.34 (29) 377.29 (10) 377.29
36. Texas	386.25	(2) 379.72 (4) 379.46 (25) 379.32
37. Utah		
38. Va.		
39. Wash.	401.51	(31) 393.21 (9) 385.01 (22) 384.97
40. West Va.		
41. Wis.	389.61	(17) 381.98 (34) 380.47 (20) 379.54
42. Wyoming		

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[1] Average of net prices for markets to which shipments were made as shown in Table 6.

[2] Figures in parenthesis denote the area and the corresponding figure denotes net price.

Table 8. Comparisons of weekly inter-area equilibrium shipments of broilers for 1961-63 and 1970 projected.

Area	Shipments in			Shipments out		
	1961-63	1970	Change1/	1961-63	1970	Change1/
	1,000 lbs					
1. Alabama				8,248.72	15,669.77	7,421.05
2. Arizona	722.83	911.54	188.71			
3. Arkansas				9,998.34	16,594.61	6,596.27
4. California	5,674.11	9,003.90	3,329.79			
5. Colorado	857.86	1,046.26	188.40			
6. Del. Md. D.C.				8,687.72	8,616.98	-70.74
7. Florida	2,439.24	3,241.61	802.37			
8. Georgia				14,478.41	17,489.14	3,010.73
9. Idaho	139.99	1.23	-138.76			
10. Illinois	4,723.70	5,637.22	913.52			
11. Indiana	677.91	2,760.27	2,082.36			
12. Iowa	1,234.56	1,497.69	263.13			
13. Kansas	989.31	1,233,46	244.15			
14. Kentucky	877.25	948.59	71.34			
15. Louisiana	518.37	484.12	-34.25			
16. Michigan	3,658.05	5,147.27	1,489.22			
17. Minn.	1,081.03	879.40	-201.63			
18. Miss.				5,425.62	10,364.58	4,938.96
19. Missouri	342.11	1,293.14	951.03			
20. Montana	360.28	396.56	36.28			
21. Nebraska	641.51	780.92	139.41			
22. Nevada	181.30	247.24	65.94			
23. New England	1,435.07	6,113.26	4,678.19			
24. New Jersey	3,409.60	4,132.67	723.07			
25. New Mexico	480.89	556.22	75.33			
26. New York	9,879.13	12,086.27	2,207.14			
27. N. C.				7,146.81	12,203.67	5,056.86
28. N. D.	318.71	365.53	46.82			
29. Ohio	4,311.31	6,104.12	1,792.81			
30. Okla.	890.63	867.62	-23.01			
31. Oregon	545.97	837.15	291.18			
32. Penn.	4,404.61	6,051.29	1,646.68			
33. S. C.	349.79	408.42	58.63			
34. S. D.	368.38	404.74	36.36			
35. Tenn.	342.61	0	-342.61	0	406.73	406.73
36. Texas	0	936.67	936.67	466.04	0	-466.04
37. Utah	372.33	565.73	193.40			
38. Va.	188.92	2,364.84	2,175.92			
39. Wash.	970.36	1,240.95	270.59			
40. West Va.	0	1,190.65	1,190.65	15.79	0	-15.79
41. Wis.	912.31	1,500.40	588.09			
42. Wyoming	167.39	189.56	22.17			

1/ Changes from 1961-63 to 1970.

Table 9. Retail prices per pound: Average reported and equilibrium 1961-63 and 1970 projected.

Area	Reported price 1/	Equilibrium prices 1961-63	Equilibrium prices 1970	Change Amount	Change Percent
	cents per pound				
1. Alabama	35.6	37.5	37.5	0	
2. Arizona	41.9	39.5	39.4	-.1	-.3
3. Arkansas	36.4	37.8	37.7	-.1	-.3
4. California	44.1	40.0	39.9	-.1	-.3
5. Colorado	39.1	39.2	39.1	-.1	-.3
6. Del. Md. D.C.	38.3	38.0	38.0	0	-
7. Florida	37.1	38.5	38.5	0	-
8. Georgia	34.7	37.5	37.5	0	-
9. Idaho	43.5	39.7	39.7	0	-
10. Illinois	38.0	38.7	38.7	0	-
11. Indiana	37.0	38.7	38.7	0	-
12. Iowa	39.9	38.9	38.8	-.1	-.3
13. Kansas	37.8	38.7	38.7	0	-
14. Kentucky	35.8	38.5	38.5	0	-
15. Louisiana	35.0	38.4	38.3	-.1	-.3
16. Michigan	37.2	38.2	38.2	0	-
17. Minn.	38.2	39.1	39.0	-.1	-.3
18. Miss.	35.5	37.6	37.5	-.1	-.3
19. Missouri	37.1	38.7	38.5	-.2	-.5
20. Montana	43.6	39.7	39.6	-.1	-.3
21. Nebraska	37.9	39.0	38.9	-.1	-.3
22. Nevada	44.7	39.8	40.0	.2	.5
23. New England	41.1	39.1	39.1	0	-
24. New Jersey	37.9	38.8	38.8	0	-
25. New Mexico	40.6	39.4	39.3	-.1	-.3
26. New York	40.2	38.9	38.9	0	-
27. N. C.	34.5	37.8	37.8	0	-
28. N. D.	39.9	39.5	39.4	-.1	-.3
29. Ohio	38.2	38.7	38.7	0	-
30. Okla.	36.5	38.7	38.6	-.1	-.3
31. Oregon	48.0	40.2	40.1	-.1	-.2
32. Penn.	38.8	38.7	38.8	.1	.3
33. S. C.	36.3	38.4	38.4	0	-
34. S. D.	40.7	39.4	39.3	-.1	-.3
35. Tenn.	36.9	38.4	37.8	-.6	-1.6
36. Texas	36.1	38.1	38.6	.5	1.3
37. Utah	40.7	39.6	39.5	.1	-.3
38. Va.	36.6	38.6	38.6	0	-
39. Wash.	50.9	40.2	40.2	0	-
40. West Va.	37.0	38.0	38.6	.6	1.6
41. Wis.	36.5	39.0	39.0	0	-
42. Wyoming	41.4	39.4	39.3	-.1	-.3

1/ Agricultural Prices, USDA.

Appendix Table 1. Population projections and consumption estimates by areas for 1970.

Area		Population projection for 1970[1]	% of U.S. projected population	Adj. population projection for 1970[2]	Average population 1961-63	Consumption index for 1970[3]	Consumption estimate for 1970[4]
		thous.	percent	thous.	thous.	index	thous. lbs.
1.	Alabama	3,273	1.57	3,357	3,329	1.0084	1,776.98
2.	Arizona	1,802	.86	1,839	1,491	1.2334	909.79
3.	Arkansas	1,435	.69	1,475	1,834	.8043	793.73
4.	California	20,296	9.74	20,826	17,002	1.2249	10,743.37
5.	Colorado	2,197	1.05	2,245	1,898	1.1828	1,043.18
6.	Del. Md. D.C.	5,588	2.68	5,730	4,479	1.2793	3,228.16
7.	Florida	5,912	2.84	6,072	5,444	1.1154	3,264.93
8.	Georgia	4,249	2.04	4,362	4,085	1.0678	2,245.47
9.	Idaho	700	.34	727	699	1.0401	372.35
10.	Illinois	11,353	5.45	11,653	10,123	1.1511	5,634.98
11.	Indiana	5,715	2.74	5,859	4,683	1.2511	2,757.44
12.	Iowa	2,874	1.38	2,951	2,775	1.0634	1,494.03
13.	Kansas	2,498	1.20	2,566	2,212	1.1600	1,232.28
14.	Kentucky	3,172	1.52	3,250	3,080	1.0552	1,681.41
15.	Louisiana	3,695	1.77	3,785	3,356	1.1278	1,919.37
16.	Michigan	10,483	5.03	10,755	8,026	1.3400	5,151.16
17.	Minn.	3,856	1.85	3,956	3,470	1.1400	1,901.10
18.	Miss.	1,999	.96	2,053	2,256	.9100	1,080.15
19.	Missouri	4,957	2.38	5,089	4,323	1.1772	2,400.68
20.	Montana	755	.36	770	701	1.0984	395.73
21.	Nebraska	1,590	.76	1,625	1,456	1.1161	778.27
22.	Nevada	453	.22	470	345	1.3623	246.98
23.	New England	11,158	5.36	11,461	10,666	1.0745	6,861.08
24.	New Jersey	6,942	3.33	7,120	6,327	1.1253	4,136.94
25.	New Mexico	1,126	.54	1,155	1,001	1.1538	554.85
26.	New York	20,023	9.61	20,548	17,461	1.1768	12,077.06
27.	N. C.	5,149	2.47	5,281	4,707	1.1219	2,685.14
28.	N. D.	710	.34	727	635	1.1449	364.89
29.	Ohio	12,258	5.88	12,573	10,047	1.2514	6,108.72
30.	Okla.	2,112	1.01	2,160	2,444	.8838	1,135.62
31.	Oregon	2,317	1.11	2,373	1,823	1.3017	1,330.30
32.	Penn.	12,508	6.00	12,829	11,387	1.1266	7,289.00
33.	S. C.	2,809	1.35	2,887	2,449	1.1788	1,522.05
34.	S. D.	776	.37	791	722	1.0955	403.56
35.	Tenn.	3,883	1.86	3,977	3,650	1.0896	2,132.47
36.	Texas	11,752	5.64	12,059	10,123	1.1912	6,374.54
37.	Utah	1,151	.55	1,176	960	1.2250	563.90
38.	Va.	4,362	2.09	4,469	4,226	1.0575	2,363.85
39.	Wash.	3,459	1.66	3,549	3,003	1.1818	2,116.20
40.	West Va.	2,015	.97	2,074	1,793	1.1567	1,128.49
41.	Wis.	4,606	2.21	4,725	4,040	1.1696	2,173.48
42.	Wyoming	379	.18	385	341	1.1290	188.98
	Total	208,346	99.97	213,820			112,562.66

1/ Current Population Report, Bureau of the Census, Series P25, No. 160, August 9, 1957.

2/ Population for December 1, 1964 for U.S. increased by 1.7% through 1970 and distributed according to percentage of projected population by states.

3/ Adjusted population for 1970 divided by average population for 1961-63.

4/ Obtained by adjusting the 1961-63 equilibrium consumption estimates by the consumption index for 1970.

Appendix Table 2. Constants[1] for broiler price equations for average week, 1961-63 and 1970.

	A values	
Area	1961-63	1970
1. Alabama	13.027611	13.035462
2. Arizona	12.253082	12.451438
3. Arkansas	12.483627	12.277800
4. California	14.616445	14.809406
5. Colorado	12.413404	12.573789
6. Del. Md. D.C.	13.382511	13.615855
7. Florida	13.536052	13.639687
8. Georgia	13.196324	13.257762
9. Idaho	11.571440	11.607778
10. Illinois	14.029526	14.163335
11. Indiana	13.270556	13.484379
12. Iowa	12.848663	12.907350
13. Kansas	12.579130	12.719214
14. Kentucky	12.959212	13.009261
15. Louisiana	13.018187	13.132407
16. Michigan	13.787732	14.065048
17. Minn.	13.017512	13.141386
18. Miss.	12.655096	12.565201
19. Missouri	13.197197	13.352756
20. Montana	11.576359	11.665631
21. Nebraska	12.184785	12.290366
22. Nevada	10.927529	11.220293
23. New England	14.291125	14.360646
24. New Jersey	13.760442	13.872331
25. New Mexico	11.843329	11.979113
26. New York	14.737293	14.892689
27. N. C.	13.325196	13.435607
28. N. D.	11.447550	11.575877
29. Ohio	14.027628	14.240023
30. Okla.	12.759043	12.641611
31. Oregon	12.579746	12.829953
32. Penn.	14.295750	14.407840
33. S. C.	12.755216	12.912065
34. S. D.	11.589196	11.676659
35. Tenn.	13.150745	13.232426
36. Texas	14.097998	14.264863
37. Utah	11.805605	11.999547
38. Va.	13.281976	13.335481
39. Wash.	13.112766	13.270960
40. West Va.	12.478242	12.617375
41. Wis.	13.116613	13.266027
42. Wyoming	10.839530	10.955909

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[1] Log_e dollars per 1,000 lbs. = A + (-.95)(Log_e Quantity).

Appendix Table 3. Estimating equations and estimates of broiler production by areas for 1970.

Area		Constants for regression[1]		Regression estimates[2]		Percentage estimate for: 1970 adjusted to 100.090	Estimated weekly supplies for 1970[3]
		a	b	Percentage for 1963	Percentage for 1970		
1.	Alabama	-1.64309	.71297	11.19	16.18	15.50	17,447.21
2.	Arizona	.08545	- .00418	.01	0	0	0
3.	Arkansas	- .27455	.65582	11.53	16.12	15.45	17,390.93
4.	California	5.74764	- .16412	2.79	1.64	1.57	1,767.23
5.	Colorado	.33782	- .01873	0	0	0	0
6.	Del. Md. D.C.	12.52618	- .06194	11.41	10.98	10.52	11,841.59
7.	Florida	1.44109	- .05697	.42	.02	.02	22.51
8.	Georgia	13.62418	.22673	17.71	18.29	17.53	19,732.24
9.	Idaho	- .02909	.01497	.24	.34	.33	371.46
10.	Illinois	1.59655	- .08448	.08	0	0	0
11.	Indiana	5.77782	- .24606	1.35	0	0	0
12.	Iowa	.81745	- .03818	.13	0	0	0
13.	Kansas	.26073	- .01109	.06	0	0	0
14.	Kentucky	1.10345	- .01685	.80	.68	.65	731.66
15.	Louisiana	.91018	.01739	1.22	1.34	1.28	1,440.80
16.	Michigan	.79255	- .03448	.17	0	0	0
17.	Minn.	- .32891	.05103	.59	.95	.91	1,024.32
18.	Miss.	-1.20400	.47267	7.30	10.61	10.17	11,447.62
19.	Missouri	3.11000	- .08333	1.61	1.03	.99	1,114.37
20.	Montana	-	-	-	-	-	-
21.	Nebraska	.65673	- .03642	0	0	0	0
22.	Nevada	-	-	-	-	-	-
23.	New England	14.43745	- .54952	4.55	.70	.67	754.17
24.	New Jersey	2.09182	- .10806	.15	0	0	0
25.	New Mexico	-	-	-	-	-	-
26.	New York	3.06309	- .15630	.25	0	0	0
27.	N. C.	1.09709	.50836	10.25	13.81	13.23	14,892.04
28.	N. D.	-	-	-	-	-	
29.	Ohio	3.05509	- .14630	.42	0	0	0
30.	Okla.	.63255	- .01515	.36	.25	.24	270.15
31.	Oregon	.65418	- .00794	.51	.46	.44	495.28
32.	Penn.	4.22545	- .12351	2.00	1.14	1.09	1,226.93
33.	S. C.	.90327	.00509	.99	1.03	.99	1,114.37
34.	S. D.	-	-	-	-	-	-
35.	Tenn.	.50455	.07552	1.86	2.39	2.29	2,577.68
36.	Texas	7.83891	- .11503	5.77	4.96	4.75	5,346.73
37.	Utah	.29309	- .01230	.07	0	0	0
38.	Va.	10.08781	- .47873	1.47	0	0	0
39.	Wash.	.97218	- .00661	.85	.81	.78	877.99
40.	West Va.	3.80182	- .16339	.86	0	0	0
41.	Wis.	1.77509	- .04564	.95	.63	.60	675.38
42.	Wyoming	-	-	-	-	-	-
	Total			99.92	104.36	100.00	112,562.66

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[1] Percent of U. S. broiler = a + bx; where x denotes year (1954 = 9 and 1970 = 25). Basic data series included 1954-1963.

[2] All negative estimates were set equal to zero.

[3] Obtained by allocating the projected consumption requirements by the 1970 adjusted percentage estimates shown in the adjacent column.

Appendix Table 4. Central points used to compute transportation cost for broilers.

Area	City	Latitude	Longitude
1. Alabama	Montgomery	32.21	86.18
2. Arizona	Casa Grande	32.51	111.45
3. Arkansas	Little Rock	34.43	92.16
4. California	Fresno	36.44	119.48
5. Colorado	Colorado Springs	38.49	104.49
6. Del. Md. D.C.	Baltimore	39.18	76.38
7. Florida	Orlando	28.33	81.22
8. Georgia	Macon	32.49	83.39
9. Idaho	Twin Falls	42.33	114.29
10. Illinois	Decatur	39.51	88.58
11. Indiana	Indianapolis	39.45	86.10
12. Iowa	Des Moines	41.32	93.32
13. Kansas	Emporia	38.24	96.11
14. Kentucky	Danville	37.48	84.48
15. Louisiana	Alexander	31.18	92.26
16. Michigan	Lansing	32.45	84.35
17. Minn.	Minneapolis - St. Paul	44.57	93.15
18. Miss.	Jackson	32.17	90.12
19. Missouri	Jefferson City	38.35	92.12
20. Montana	Lewistown	47.50	109.27
21. Nebraska	Columbus	41.25	97.21
22. Nevada	Austin	39.30	117.05
23. New England	Concord, N. H.	43.12	71.32
24. New Jersey	Fruhold	40.16	74.15
25. New Mexico	Albuqerque	35.50	109.36
26. New York	Cortland	42.36	79.90
27. N. C.	High Point	35.57	80.00
28. N. D.	Bismark	46.48	100.46
29. Ohio	Marion	40.37	83.70
30. Okla.	Oklahoma City	35.28	97.31
31. Oregon	Salem	44.56	123.10
32. Penn.	Harrisburg	40.16	76.50
33. S. C.	Camden	34.15	80.37
34. S. D.	Pierre	44.22	100.20
35. Tenn.	Mufreesboro	35.51	86.24
36. Texas	Waco	31.35	97.70
37. Utah	Provo	40.15	111.40
38. Va.	Charlottesville	38.20	78.29
39. Wash.	Seattle	47.25	122.25
40. West Va.	Elkins	38.54	79.50
41. Wis.	Madison	43.50	89.22
42. Wyoming	Casper	42.51	106.18

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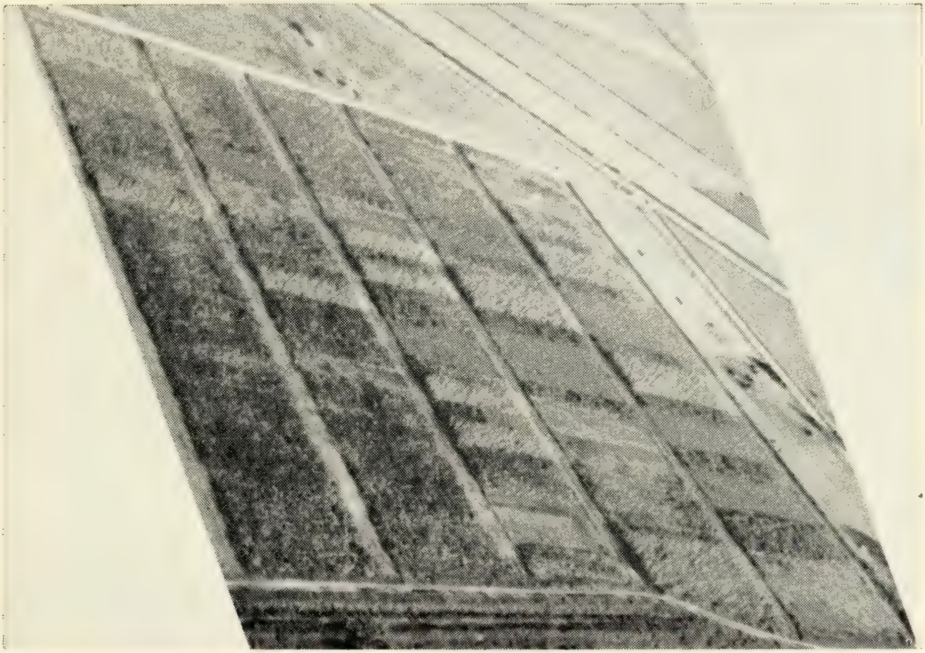

Aerial view of crop rotation plots at Delta Branch Experiment Station.

The Influence Of Cropping Systems On Soil Properties And Crop Production

Mississippi State University

AGRICULTURAL EXPERIMENT STATION

HENRY LEVECK, Director

STATE COLLEGE MISSISSIPPI

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INFLUENCE OF CROPPING SYSTEMS ON SOIL PROPERTIES AND CROP PRODUCTION

By W. I. SPURGEON AND P. H. GRISSOM

INTRODUCTION

Cotton has been grown continuously on many of the Delta soils in Mississippi for more than 50 years. The organic matter content of the majority of these soils is very low (.75-1.5%). An average cotton crop of this area returns approximately one ton per acre of crop residue to the soil annually. The crop residue from continuous cotton may not be sufficient to maintain the existing low level of soil organic matter. A further decline in organic matter could seriously impair the physical properties of the soil.

Physical, chemical and biological methods have been used in an effort to improve soil physical properties. This study is concerned with the biological method. There have been indications that soils are not affected alike by different crops and that pasture crops may have the most beneficial effect on the soil and on the yield of crops that follow. The need exists for information which may be translated into farm practice that will improve soil properties and increase crop production.

The specific objectives of this study were as follows:

1—To evaluate the influence of selected cropping systems on subsequent cotton yields.

2—To measure the residual effect of a sod crop on cotton yields.

3—To study the effect and the duration of the effect of 1, 2, 3, and 4 years of corn, soybeans and sod crops on soil properties and subsequent cotton yields.

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[1] Associate agronomist and former agronomist, respectively, Delta Branch of the Mississippi Agricultural Experiment Station, Stoneville, Miss.

REVIEW OF LITERATURE

The effect of short and long-time cropping systems on soil properties and crop yields have been extensively investigated throughout the humid region.

Numerous studies (1, 5, 8, 12) have shown that winter and summer legumes, when turned under as a green manure crop, increases the yield of crops that follow. The yield increase of crops following legumes is associated with the amount of nitrogen returned to the soil by the legume (5, 8, 12).

Rotations of short and long duration involving legumes and/or sod crops, have increased the yield of various crops compared with continuous cropping of a specific crop (4, 10, 14, 16). Others (2, 18) have reported no yield increase as affected by rotations. The yield increase of crops in rotations has been attributed to various factors. However, one of the most important factors is reported to be an improvement of soil properties.

Rotations involving a sod crop have been reported to increase soil organic matter and total nitrogen (2, 7, 9, 15). In some rotations perennial legumes, such as alfalfa and clovers, have been effective in maintaining and/or increasing soil organic matter and total nitrogen (7, 9, 16). With respect to soil organic matter and nitrogen maintenance long-term rotations have been more effective than short-term ones (2, 7).

Grissom (5) in a 12-year study with Delta soils of Mississippi found that winter legumes slightly decreased soil pH, and exchangeable Ca and Mg. Brage and associates (2) found that available soil phosphorus decreased as the length of rotation increased. Soil pH was not affected by length of rotation.

The effect of various crop rotations on soil physical properties have been reported by numerous investigators (11, 12, 14, 15, 16, 17, 19, 20).

Compared with continuous cropping, rotations with a sod or combination sod-legume crop increases soil aggregation as measured by the percent of water-stable aggregates (11, 14, 15, 16, 17, 20). Olmstead (13) found that cropping systems, of 30 to 40 years duration, had no significant effect on water-stable aggregates on plots of the Dry Land Agricultural Project at Hays, Kansas.

Page and Willard (14) found that yield of corn in rotations was correlated with air space porosity and the degree of soil aggregation. Van Bavel and Schaller (16) also reported that a highly significant positive correlation was found between soil aggregation and corn yields. Conversely, Strickling (15) found no apparent relationship between yield and soil aggregation. He also found no correlation between aggregate stability and volume weight of soil aggregates.

Vhland (17) found no difference in the volume weight of soil from continuous corn as compared with that from a corn-wheat-clover rotation. Williams and Doneen (19) reported that gramineous summer and winter green manure crops improved soil structure as indicated by infiltration measurements during the subsequent growing season. Annual green legumes did not improve infiltration.

To summarize, the literature indicates that cropping systems which include sod and/or legume crops increases the yield of cultivated crops grown within the system. The yield increase of the cultivated crop has usually been correlated with an increase in soil organic matter, or an improvement in soil physical properties.

EFFECT OF SELECTED CROPPING SYSTEMS ON THE SUBSEQUENT YIELD OF COTTON

Experimental Procedure

A short-term rotation was initiated in 1953 on a Bosket very fine sandy loam soil. The 8 cropping systems with treatment numbers are shown in Table 1. Hereafter, treatment numbers are used when referring to the various cropping systems.

The experimental design was a randomized block with 4 replications. Plot size was 80 x 242 feet, which allowed twenty-four 40-inch rows for each cultivated crop. Nitrogen, as anhydrous ammonia, was the only fertilizer used on the cultivated crops. Both cotton and corn received 100 pounds of N each year prior to planting. Cotton following a winter legume and/or sweet clover (treatments 2 and 4) received 60 pounds of N as a preplant application. Oats with sweet clover (treatment 4) received no nitrogen and oats alone (treatment 3) were top-dressed with 45 pounds of N per acre as ammonium nitrate.

In 1955 one-half of 12 rows of each cotton, corn and soybean plot were subsoiled. In 1956, 12 rows of same plots were subsoiled; six which had been subsoiled in 1955, and six which had not been previously subsoiled. Therefore, the original 24 row plots were subdivided in 1956 into four 6-row plots consisting of no subsoil treatment, subsoiled in 1955, subsoiled 1955 and 1956, and subsoiled in 1956.

The cropping cycle was terminated at the end of the 1957 season. Cotton was grown on the plots for two additional years (1958 and 1959) in an attempt to

Table 1. Selected cropp ing systems 1953-1959.

Treatment number	1953	1954	1955	1956	1957	1958	1959
	Crops for different years						
1	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton	Cotton
2	Cotton+W.L.*	Cotton+W.L.	Cotton+W.L.	Cotton+W.L.	Cotton+W.L.	Cotton+W.L.	Cotton
3	Oats	Cotton	Cotton	Oats	Cotton	Cotton	Cotton
4	Oats+S.C.**	Oats+S.C.	Cotton	S.C.	Cotton	Cotton	Cotton
5	Corn	Cotton	Corn	Cotton	Corn	Cotton	Cotton
6	Soybeans	Cotton	Soybeans	Cotton	Soybeans	Cotton	Cotton
7	Soybeans	Corn	Cotton	Soybeans	Corn	Cotton	Cotton
8	Soybeans	Soybeans	Cotton	Soybeans	Soybeans	Cotton	Cotton

*Winter legume. **Sweet clover

Table 2. Crop yields as influenced by cropping systems on a Bosket very fine sandy loam soil.

Cropping systems	1953	1954	1955	1956	1957	1958	1959	Aperage cotton yield[1]	Continuous cotton[2]	Continuous cotton+ W.L.[3]
	Pounds of seed cotton/A and Bu/A of beans, corn and oats									
Continuous cotton	1014	744	2296	861	1297	2103	1687	1429	--------	--------
Continuous cotton+W.L.	1069	658	2354	529	1282	2204	1717	1402	--------	--------
Oats 1 year, cotton 2 years	(75.1)*	798	2333	(68.6)	1768	2373	1862	1827	1625	1643
Oats+S.C. 2 years, cotton 1 year	(75.3)	(64.2)	2557	--------	1066	2196	1952	1943	1846	1889
Corn 1 year, cotton 1 year	(13.4)	973	(58.6)	1004	(83.8)	1995	1844	1455	1349	1277
Soybeans 1 year, cotton 1 year	(4.2)	860	(6.2)	908	(18.2)	2229	1839	1459	1349	1277
Soybeans-corn-cotton	(4.7)	(4.6)	2331	(5.0)	(86.7)	2207	1556	2031	2029	2092
Soybeans 2 years, cotton 1 year	(5.1)	(8.5)	1936	(5.0)	(18.3)	2152	1494	1861	2029	2092

*Bean, corn and oat yields in parenthisis.

[1] Cotton yields for all systems, all years averaged.

[2] Continuous cotton yield for years in which there is a basis for comparison with cotton yield from other cropping systems.

[3] Cotton plus winter legume averaged same as[2].

determine the residual effect of the cropping systems on cotton yield.

Results and Discussion

The bean, corn, cotton and oat yields by years for the different cropping systems are shown in Table 2. The last three columns of Table 2 shows the average cotton yields of the different cropping systems versus those of comparable years for continuous cotton and continuous cotton plus a winter legume. There was very little difference in yield between continuous cotton with or without the winter legume which replaced 40 pounds of nitrogen each year. The only cropping system which increased cotton yield as compared with continuous cotton was the system involving 1 year of oats and 2 years of cotton. The average yields, based upon comparable years, were 1625 pounds of seed cotton per acre for continuous cotton and 1827 pounds for the 1 year of oats and 2 years of cotton.

Subsoiling the soil significantly increased cotton yields in both 1955 and 1956. In 1955 and 1956 the subsoil treatment increased yields 358 and 248 pounds of seed cotton per acre, respectively. There was no indication, as measured by cotton yield, that subsoiling was effective for more than one year.

The climatic conditions varied considerably from year to year over the 5-year period (1953-1957). Two years, 1954 and 1956 had extremely dry growing seasons. The 1957 growing season was exceptionally wet. During the dry years, yields were reduced when cotton followed a winter legume. Apparently the soil moisture reserve was depleted to some extent by the winter legume. In 1957, the wet season, yields were also reduced where cotton followed the winter legume. There was excessive vegetative growth which indicated the cotton plants had access to more N than was needed. Maturity was delayed and an early freeze reduced yield.

RESIDUAL EFFECT OF A SOD CROP ON COTTON YIELDS

Experimental Procedure

In 1955 a Dundee silty clay loam soil, which had been in a Johnsongrass-red clover sod for a period of 4 years, was selected to measure the residual effect of sod on subsequent cotton yields. The experimental design was a randomized block with 8 replications. The plot size was eight 40-inch rows 100 feet long. Starting in 1956 one plot per replication was removed from sod each year from 1956 through 1959 and planted to cotton. After removal of each plot from sod, cotton was grown on them continuously through 1960. Table 4 shows an outline of the treatments for different years.

Adapted cotton varieties were planted each year between May 1 and 20. Nitrogen, as anhydrous ammonia, was applied before planting at the rate of 100 pounds of N per acre. The cultural practices were identical to those followed in general cotton production.

Results and Discussion

The cotton yields as influenced by the sod crop are shown in Table 5.

Cotton yield the first year after sod was lower each year (1957, 1958 and 1959) as compared with yields from cotton planted 2 and 3 years after sod. In 1958 and 1959 the yields of cotton 2 years after sod was significantly higher than that from cotton 1 year after sod. In 1959 both 1 and 2 year cotton after sod produced significantly less than 3 and/or 4 years of cotton after sod.

The factor responsible for low cotton yields the first and second year that cotton was grown after sod is attributed to a heavy weed infestation. The Johnsongrass sod was difficult to eradicate the first crop year. Competition by the grass

Table 4. Treatments of the residual sod experiment.

Treatment Number	Crops by years					
	1955	1956	1957	1958	1959	1960
1	Sod	Cotton	Cotton	Cotton	Cotton	Cotton
2	Sod	Sod	Cotton	Cotton	Cotton	Cotton
3	Sod	Sod	Sod	Cotton	Cotton	Cotton
4	Sod	Sod	Sod	Sod	Cotton	Cotton

Table 5. The influence of a sod crop on the yield of cotton.

Treatment Number	Year removed from sod and planted to cotton	Pounds of seed cotton per acre			
		1957	1958	1959	1960
1	1956	1674	1320	1333	2879
2	1957	1476	1177	1416	2908
3	1958	-------	710	917	2733
4	1959	-------	-------	714	2747
L.S.D. @ .05	-------	N.S.	440	380	N.S.

for soil moisture and nutrients apparently reduced cotton yield.

If the sod plots had been fallowed for a year or for one summer the Johnsongrass probably would have been easier to control in the subsequent cotton crop. The cotton yields in 1960 were higher and more uniform for all treatments. The grass presented no problem in 1960 because most of it had been eradicated.

INFLUENCE OF CONTINUOUS COTTON AND 1, 2, 3, AND 4 YEARS OF CORN, SOD AND SOYBEANS ON SOIL PROPERTIES AND COTTON YIELDS

Experimental Procedure

One test was started in 1956 on a Dubbs silt loam soil. A similar test was initiated on a Sharkey clay soil in 1957. Both soils had been cropped in cotton for several years.

A split plot design was used, consisting of 9 replications on the silt loam and 6 replications on the clay soils. Three replications were initiated on the silt loam in 1956, three in 1957 and three in 1958. Three replications were started on the clay soil in 1957 and three in 1958. The main plots for both soils were crops consisting of corn, soybeans and sod as Coastal Bermudagrass. Continuous cotton was included as a treatment but was not randomized.

The subplots were crop sequences of 1, 2, 3 and 4 years duration for each crop. One 8-row plot of each crop per replication was initiated annually over a 4-year period. For example, on the silt loam soil, one plot of corn was started in replications 1, 2, and 3 in 1956 and continued in corn through 1959; another plot was started in 1957 with continuous corn through 1959; another in 1958 with continuous corn through 1959; and the last plot was planted to 1 year of corn in 1959. In 1960 all crops of replications 1, 2 and 3 were plowed under and planted to cotton. The same procedure was followed for the other replications and crops except that the initation dates were different.

Cultural practices for all crops were the same as those generally recommended for the area. The cotton planted, after removal of the different crops, received 90 pounds of N per acre as anhydrous ammonia.

Cotton yields were measured through 1963. On the silt loam soil this gave yield comparisons between the first, second, third and fourth year of cotton after 1, 2, 3 and 4 years of corn, sod and soybeans. On the clay soil, yield comparisons were made between the first, second and third year of cotton following 1. 2, 3 and 4 years of corn, sod and soybeans.

The soil physical properties measured were bulk density and water-stable aggregates. These measurements were made only on the silt loam soil. All soil samples were taken after the crops had been removed and the plots planted to cotton. The soil samples for the two physical measurements were obtained each year in August after the last cultivation. Additional samples were obtained from all plots of both soils to a depth of 6 inches each year prior to planting cotton. These samples were analyzed by the Soil Test Laboratory at Mississippi State University for pH, organic matter, available P_2O_5 and exchangeable potassium.

A modification of Bryant and associates' (3) method was used for the determination of water-stable soil aggregates. The data are expressed as an average of the 2 and 5 minute oscillation periods.

The degree of weed infestation of cotton following the different crops was determined by recording the hoe labor in man hours for each plot.

Results and Discussion

The primary purpose of this study was to evaluate the effect of the cropping systems on soil properties and subsequent cotton yields. However, the yields were recorded for cotton, corn and soybeans during the cropping period for 1956-1961. These data are shown in appendix Table 3.

Corn grown on the soil for more than 1 year reduced subsequent corn yields. The 3-year average (1959-1961) yields for 1, 2, 3 and 4 years of corn on the Dubbs silt loan soil were 67.5, 63.0, 56.6 and 41.6 bushels per acre, respectively. Soybean yields, on the same soil, were not affected when grown for 1, 2, 3 and 4 years.

On the Sharkey clay soil yields of both corn and soybeans were too variable to make any estimate of the effect of cropping sequence on yield. The corn crop in 1960 was a complete failure.

Effect on Soil Properties: Table 6 shows the average bulk density and per-

Table 6. The influence of cropping systems on the bulk density and percentage water-stable aggregates of a Dubbs silt loam soil.

	Bulk density			Percent water-stable aggregates*		
Treatment	1st-year[1] cotton	2nd-year[2] cotton	3rd-year[3] cotton	1st-year[2] cotton	2nd-year[3] cotton	3rd-year[3] cotton
Cotton each year	1.32	1.35	1.34	13.7	12.0	21.4
1 year in corn	1.32	1.35	1.27	14.8	17.8	21.4
2 years in corn	1.31	1.34	1.29	14.9	18.0	25.0
3 years in corn	1.31	1.33	1.29	15.4	14.0	25.0
4 years in corn	1.30	1.33	1.30	15.8	15.6	27.4
Corn average	1.31	1.34	1.29	15.2	16.4	24.7
1 year in soybeans	1.32	1.33	1.31	16.1	12.6	19.0
2 years in soybeans	1.33	1.33	1.32	9.6	11.2	17.0
3 years in soybeans	1.31	1.31	1.32	10.4	10.0	17.8
4 years in soybeans	1.31	1.32	1.33	14.7	13.2	22.0
Soybean average	1.32	1.32	1.32	12.7	11.8	18.9
1 year in sod	1.28	1.35	1.32	12.3	15.0	14.4
2 years in sod	1.28	1.34	1.32	14.0	11.2	18.0
3 years in sod	1.31	1.31	1.31	18.4	12.2	19.8
4 years in sod	1.31	1.31	1.31	18.3	15.4	22.6
Sod average	1.30	1.33	1.32	15.8	13.5	18.7

*Average of 2 and 5 minute oscillations.

[1] 3-year average. [2] 2-year average. [3] 1-year only.

Table 7. The influence of cropping systems on the available P_2O_5 and exchangeable potassium of a Dubbs silt loam soil.

	Lbs/A available P_2O_5			Lbs/A exchangeable potassium		
Treatment	1st-year[1] cotton	2nd-year[2] cotton	3rd-year[3] cotton	1st-year[1] cotton	2nd-year[2] cotton	3rd-year[3] cotton
Cotton each year	126	156	192	338	331	378
1 year in corn	120	134	206	338	321	419
2 years in corn	145	159	242	368	385	422
3 years in corn	132	170	228	353	373	356
4 years in corn	114	141	206	340	348	465
Corn average	128	151	220	350	357	441
1 year in soybeans	114	134	151	331	305	343
2 years in soybeans	109	123	155	309	289	427
3 years in soybeans	107	126	150	319	296	348
4 years in soybeans	103	128	151	321	295	329
Soybean average	108	128	152	320	296	362
1 year in sod	149	154	174	367	383	452
2 years in sod	124	134	167	379	371	427
3 years in sod	111	132	141	400	383	395
4 years in sod	107	126	171	419	368	403
Sod average	123	136	163	391	376	419

[1] 3-year average. [2] 2-year average. [3] 1-year only.

Table 8. The influence of cropping systems on the percent organic matter and pH of a Dubbs silt loam soil.

	Percent organic matter			Soil pH		
Treatment	1st-year[1] cotton	2nd-year[2] cotton	3rd-year[3] cotton	1st-year[2] cotton	2nd-year[2] cotton	3rd-year[3] cotton
Cotton each year	1.04	1.07	1.00	6.1	6.1	6.0
1 year in corn	1.08	1.07	1.00	6.1	6.0	6.0
2 years in corn	1.09	1.07	1.21	6.1	6.2	6.1
3 years in corn	1.12	1.14	1.05	6.0	6.2	6.3
4 years in corn	1.09	1.13	1.15	5.9	6.1	6.0
Corn average	1.09	1.10	1.10	6.0	6.1	6.1
1 year in soybeans	1.02	0.97	0.98	6.2	6.0	6.0
2 years in soybeans	0.97	0.99	0.95	6.1	6.0	5.7
3 years in soybeans	1.02	1.07	1.05	6.0	6.0	5.9
4 years in soybeans	1.07	1.02	1.02	6.1	6.1	6.0
Soybean average	1.02	1.01	1.00	6.1	6.0	5.9
1 year in sod	1.21	1.06	1.08	6.4	6.4	6.3
2 years in sod	1.14	1.17	1.11	6.3	6.1	5.9
3 years in sod	1.18	1.08	1.08	6.3	6.1	6.0
4 years in sod	1.19	1.18	1.05	6.3	5.9	5.8
Sod average	1.18	1.12	1.08	6.3	6.1	6.0

[1] 3-year average. [2] 2-year average. [3] 1-year only.

cent of water-stable aggregates of the Dubbs silt loam soil for the first, second and third years of cotton following the different cropping systems. Bulk density was not affected by any of the cropping systems. The percentage of water-stable aggregates were significantly reduced in the first- and second-year cotton crops following soybeans. The percentage of soil water-stable aggregates, for both first- and second-year cotton following the cropping systems, were in the order of sod, corn, cotton, soybeans.

The effect of cropping systems on the available P_2O_5 and exchangeable potassium of the Dubbs silt loam soil is shown in Table 7. There was no significant difference in available P_2O_5 as affected by the different crops. However, during the first, second and third years of cotton the available P_2O_5 was lower in the soil from the soybean plots as compared to those of cotton, corn and sod.

As indicated by the first year of cotton (Table 7) the available P_2O_5 was 149, 124, 111, and 107 pounds per acre for 1, 2, 3 and 4 years of sod, respectively. The same trend, although not significant was evident in the first year of cotton following 1, 2, 3 and 4 years of soybeans.

The cropping systems did not significantly affect the amount of exchangeable soil potassium. The soil potassium was lower (Table 7) from cotton following soybeans as compared with cotton following cotton, corn and sod. This same trend persisted through the first, second and third years of cotton following the different crops.

The effect of the cropping systems on soil organic matter and pH is shown in Table 8. The soil organic matter content was significantly increased in the first year of cotton after sod as compared with the first year of cotton after soybeans. During the second and third years of cotton the organic matter content of soil from the sod crop was higher than from soil of the bean and corn plots but not significantly higher.

The soil pH was not affected by any of the cropping systems.

The cropping systems had very little effect on the chemical properties of the Sharkey clay soil. Appendix Table 12 shows the soil pH, available P_2O_5, and percent organic matter as measured during the first and second years of cotton that followed the different crops. The exchangeable potassium is not included because all plots regardless of crops or crop sequence had more than 640 pounds of exchangeable K per acre.

Effect on Weed Control: The effect of the different cropping systems on weed control has been reported in a previous publication (6). The data from this publication are shown in Table 9.

The hoe labor requirement varied considerably for cotton following the different crops. On the Dubbs soil, cotton the first year after corn required about twice the hoe labor as that for continuous cotton and/or soybeans. The hoe labor for the first year of cotton after sod was triple that of either continuous cotton or soybeans. The hoe labor for the second year of cotton was considerably less.

There was very little difference between crops. However, the hoe labor requirement of second year cotton after

Table 9. The influence of cropping systems on the hoe labor requirements in cotton on a Dubbs silt loam and a Sharkey clay soil.

	Dubbs silt loam		Sharkey clay	
Treatment	1st-year[1] cotton	2nd-year[2] cotton	1st-year[2] cotton	2nd-year[3] cotton
		Man hours per acre		
Cotton each year	24	21	86	55
1 year in corn	38	23	105	61
2 years in corn	42	24	114	70
3 years in corn	45	23	112	73
4 years in corn	49	31	114	77
Corn average	44	25	111	70
1 year in soybeans	24	15	71	41
2 years in soybeans	19	13	57	36
3 years in soybeans	19	14	54	39
4 years in soybeans	20	13	58	38
Soybean average	21	14	60	39
1 year in sod	63	27	111	69
2 years in sod	73	30	134	93
3 years in sod	68	22	170	108
5 years in sod	78	24	179	119
Sod average	71	26	149	97

[1] 3-year average. [2] 2-year average. [3] 1-year only.

Table 10. The influence of cropping systems on subsequent cotton yields on a Dubbs silt loam soil.

Treatment	1st-year[1] cotton	2nd-year[1] cotton	3rd-year[2] cotton	4th-year[3] cotton
	Pounds of seed cotton per acre			
Cotton each year	2384	2693	2742	2843
1 year in corn	2668	2876	2810	2799
2 years in corn	2596	2895	2853	2563
3 years in corn	2605	2994	2972	2862
4 years in corn	2715	2889	2889	2885
Corn average	2646	2914	2881	2777
1 year in soybeans	2398	2688	2927	2696
2 years in soybeans	2112	2707	2876	2658
3 years in soybeans	2148	2690	2845	2683
4 years in soybeans	1951	2753	2829	2756
Soybean average	2152	2710	2869	2699
1 year in sod	2475	2887	2829	2919
2 years in sod	2233	2768	2913	2986
3 years in sod	2334	2711	2945	2834
4 years in sod	2072	2792	2938	2913
Sod average	2279	2789	2906	2913

[1] 3-year average. [2] 2-year average. [3] 1-year only.

soybeans was slightly less than that for the other crops. Johnsongrass and nutgrass were the primary weeds that caused the high hoe labor in cotton following the corn and sod crops on the silt loam soil.

On the Sharkey clay soil the hoe labor requirement was very high for both first- and second-year cotton that followed the corn and sod crops. The lowest hoe time was required where cotton followed soybeans. The highest amount of hoe labor was required where cotton followed sod. The weeds which were difficult to control on the Sharkey soil were nutgrass and Coastal Bermudagrass. Nutgrass presented a problem in cotton after corn. The Coastal Bermudagrass was difficult to eradicate in cotton after sod. The Coastal Bermudagrass had not been completely eradicated after the third year of cotton.

The weed infestation in cotton following the sod crop may not have been so severe if the soil had been fallowed for a year after removal of the sod. A combination of Spring fallow plus a soybean crop the first year after sod may also be effective in reducing the weed population in a subsequent cotton crop.

Effect on Subsequent Cotton Yield: The average yields of the first, second, third and fourth years of cotton following the different cropping systems, on the Dubbs silt loam soil, are shown in Table 10.

The greatest yield difference between cropping systems occurred in the first year of cotton. These differences, based on the 3-year average, were not statistically significant. The yields of the first year of cotton following corn, soybeans and sod were 2646, 2152 and 2279 pounds of seed cotton per acre, respectively. The yield of continuous cotton for the same period was 2384 pounds of seed cotton per acre.

A significant interaction of crops x years occurred in the first year of cotton (Appendix Table 1). The first-year cotton yields after soybeans were significantly lower than comparable yields after corn and sod for the years of 1960 and 1961. In 1962 the first-year cotton yields after sod were significantly lower than comparable yields after corn and soybeans. In 1962 cotton yields after sod were reduced by a heavy weed infestation. The yield reduction of cotton after soybeans in 1960 and 1961 cannot be satisfactorily explained. The available P_2O_5

and exchangeable potassium was lower in soil that had been cropped in soybeans. However, subsequent cotton yields could not be correlated with soil P_2O_5 or potassium.

The average yields of the second, third and fourth years of cotton were not affected by the different cropping systems.

Table 11 shows the average yields of the first, second and third years of cotton following the different cropping systems on the Sharkey clay soil.

The cropping systems on the Sharkey clay soil, as on the Dubbs silt loam, exhibited the greatest effect on yield during the first year of cotton. The first year average cotton yields following the corn, soybean and sod crops were 1053, 1426, and 736 pounds of seed cotton per acre, respectively. The yield of continuous cotton for the same period was 1233 pounds of seed cotton per acre.

Two factors were probably responsible for the higher yield of cotton following soybeans. First, the weed infestation of cotton following soybeans was less than in cotton following the other crops. Second, nitrogen loss through denitrification is a problem on the Sharkey soil. The cotton following soybeans probably had access to more soil nitrogen.

The low cotton yield following the sod crop was caused primarily, by competition from residual Coastal Bermudagrass. The Coastal Bermudagrass was difficult to eradicate. This is reflected in the first-year cotton yields following 1, 2, 3 and 4 years of sod. The cotton yields after 1, 2, 3 and 4 years of sod were 1183, 916, 554 and 293 pounds of seed cotton per acre, respectively.

The average yields of the second and third years of cotton were similar for all of the cropping systems. The weed problem was not as severe during the second and third years of cotton following the corn and sod crops.

Table 11. The influence of cropping systems on subsequent cotton yields on a Sharkey clay soil.

Treatment	1st-year[1] cotton	2nd-year[1] cotton	3rd-year[2] cotton
	Pounds of seed cotton per acre		
Cotton each year	1233	1125	1507
1 year in corn	1161	1165	1897
2 years in corn	1008	1198	1853
3 years in corn	894	1285	1996
4 years in corn	1059	1265	1945
Corn average	1053	1228	1921
1 year in soybeans	1493	1135	1748
2 years in soybeans	1384	1039	1897
3 years in soybeans	1350	1086	1576
4 years in soybeans	1478	1041	1746
Soybean average	1426	1075	1742
1 year in sod	1183	1208	1754
2 years in sod	916	1235	1736
3 years in sod	554	996	1941
4 years in sod	293	1039	1864
Sod average	736	1119	1824

[1] 2-year average. [2] 1-year only.

SUMMARY

A test designed to measure the influence of 8 selected cropping systems on subsequent cotton yield was conducted from 1953-1959. Only one of the 8 cropping systems (1 year of oats and 2 years of cotton) increased cotton yield above that obtained from continuous cotton.

The residual effect of a sod crop on cotton yield was measured over a 4-year period from 1956-1960. Cotton yield the first year after sod was significantly lower than yields from the second and third year of cotton after sod. The yield reduction in the first year of cotton following sod is attributed to a heavy weed infestation.

Two experiments were initiated, one in 1956 on a Dubbs silt loam and one in 1957 on a Sharkey clay, to measure the effect of 1, 2, 3 and 4 years of corn, soybean and sod crops on soil properties and subsequent cotton yields.

Effects On Soil Properties

The effects of the cropping systems on the soil properties, as measured during the first, second and third years of cotton following the different crops are shown below:

1—The percent of water-stable soil aggregates was significantly reduced by the soybean crop on the Dubbs soil.

2—As compared with continuous cotton, corn and sod the soybeans reduced the amount of available P_2O_5 and exchangeable potassium of the Dubbs soil, but not significantly.

3—The soil bulk density and pH were not affected by any of the cropping systems.

4—The percent organic matter content of the Dubbs soil was significantly increased by the sod crop.

5—The cropping systems had no effect on pH, percent organic matter content, exchangeable potassium and available P_2O_5 of the Sharkey clay soil.

Effects On Cotton Yields

The effects of the cropping systems on subsequent cotton yields are shown below:

1—On the Dubbs soil, 2 out of 3 years (1960-1961) the yield of first-year cotton after soybeans was lower than the yield of first-year cotton after corn and sod. The yield of the first-year cotton after soybeans was also lower than that from continuous cotton.

2—On the Dubbs soil, 1 out of 3 years (1962), the yield of first-year cotton after sod was lower than the yields of first-year cotton after corn and soybeans. First-year cotton after sod also produced less than continuous cotton. The yield reduction after sod in 1962 was caused by a severe weed infestation.

3—On the Sharkey soil, the yield of the first-year cotton after sod was considerably lower both years (1961-1962) than the yields from first-year cotton after corn and soybeans. Yield from first-year cotton after sod was lower than that from continuous cotton. The yield reduction in the first year of cotton after sod was caused by the residual Coastal Bermudagrass which was difficult to eliminate.

4—The yield of second and third-year cotton, following the cropping systems, was not significantly affected by any of the crops on either soil type.

The results of these experiments indicate no particular advantage for any of the rotations or croppings systems. The yield of continuous cotton was equal or superior to the yield of cotton that followed the various crops.

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Appendix Table 1. Analysis of variance of soil properties and cotton yield during first year cotton following the different cropping systems on a Dubbs silt loam soil.

Source	d f	Cotton yield M S	P_2O_5 M S	Potassium M S	Organic matter M S	Water-stable aggregates M S
Crops	2	2218.02	3634.75	46081.46	0.237*	0.377*
Years	2	980.92	25700.25	234878.90**	0.230*	0.251
Crops x years	4	2428.79**	8741.54	16579.63	0.027	0.017
Replications within years	6	251.11	4853.75	5925.82	0.111	0.114
Error a	12	202.83	6742.58	15508.58	0.047	0.055
Sequence within crops	9	185.90	1717.74*	2461.05	0.009	0.091
Sequence within crops x years	18	107.04**	516.54	823.65	0.017	0.059
Error b	54	45.54	532.74	1401.74	0.017	0.026
Total	107					

**Significant at the 1% level. *Significant at the 5% level.

Appendix Table 2. Analysis of variance of yields for first and second year cotton following the different cropping systems on a Sharkey clay soil.

Source	d f	1st-year cotton M S	2nd-year cotton M S
Crops	2	2683.55	139.47
Years	1	9261.61*	4105.69**
Crops x years	2	1055.81*	174.97
Replications within years	4	78.85	57.34
Error a	8	133.39	155.51
Sequence within crops	6	464.81*	54.84
Sequence within crops x years	12	131.31**	15.90
Error b	36	19.45	29.26
Total	71		

**Significant at the 1% level. *Significant at the 5% level.

Appendix Table 3. Average cotton, corn and soybean yields from the Dubbs silt loam and Sharkey clay soils during the cropping sequence period from 1956-1961.

Treatment	1956	1957	1958	1959	1960	1961
				Dubbs silt loam		
Cotton	--------	1804[1]	2510	2710	2316	------
1 year in corn	67.5[2]	89.9	94.1	69.8	66.3	66.4
2 years in corn	--------	--------	82.3	58.7	65.2	65.1
3 years in corn	--------	--------	75.1	50.2	59.5	60.0
4 years in corn	--------	--------	--------	32.9	52.2	39.6
1 year in soybeans	--------	41.4[2]	41.7	45.6	47.1	------
2 years in soybeans	--------	38.3	41.3	44.5	48.1	------
3 years in soybeans	--------	--------	37.2	44.3	45.8	------
4 years in soybeans	--------	--------	--------	45.2	45.2	------
				Sharkey clay		
Cotton		1171	787	982	--------	------
1 year in corn		47.2	34.3	13.9	--------	39.9
2 years in corn		--------	23.7	5.6	--------	44.6
3 years in corn		--------	--------	11.4	--------	40.8
4 years in corn		--------	--------	--------	--------	38.6
1 year in soybeans		12.0	25.3	15.1	29.8	------
2 years in soybeans		--------	26.4	10.9	35.8	------
3 years in soybeans		--------	--------	14.1	31.2	------
4 years in soybeans		--------	--------	--------	34.1	------

[1] Pounds per acre of seed cotton.

[2] Bushels per acre of corn and soybeans.

Appendix Table 4. Average cotton yields from a Dubbs silt loam soil for the first, second and third years following 1, 2, 3 and 4 years of corn, soybean and sod crops.

	Pounds of seed cotton per acre									
	1st-year cotton			2nd-year cotton			3rd-year cotton		4th-year cotton	
Treatment	1960	1961	1962	1961	1962	1963	1962	1963	1963	Average
Cotton each year	2121	2573	2459	2714	2256	3109	2450	3033	2843	2618
1 year in corn	2797	2636	2571	2763	2675	3190	2542	3078	2799	2783
2 years in corn	2493	2756	2540	2819	2731	3136	2542	3164	2563	2749
3 years in corn	2529	2764	2523	2982	2822	3179	2813	3131	2862	2845
4 years in corn	2641	2789	2714	2822	2748	3098	2648	3129	2885	2830
Corn average	2615	2736	2587	2846	2744	3151	2636	3125	2777	2802
1 year in soybeans	2430	2305	2460	2634	2485	2945	2512	3342	2696	2645
2 years in soybeans	1600	2182	2554	2657	2470	2995	2666	3085	2658	2541
3 years in soybeans	1884	2073	2488	2626	2532	2912	2472	3217	2683	2543
4 years in soybeans	1295	2030	2528	2679	2617	2963	2564	3093	2756	2503
Soybean average	1802	2148	2507	2649	2526	2954	2553	3184	2699	2558
1 year in sod	2665	2798	1962	2780	2723	3158	2602	3055	2919	2740
2 years in sod	2596	2660	1444	2936	2434	2934	2753	3073	2986	2646
3 years in sod	2434	2826	1741	2855	2419	2858	2902	2987	2834	2651
4 years in sod	2271	2786	1159	2928	2467	2982	3035	2840	2913	2598
Sod average	2492	2767	1577	2875	2510	2983	2823	2989	2913	2659

Appendix Table 5. Average cotton yields from a Sharkey clay soil for the first, second and third years following 1, 2, 3 and 4 years of corn, soybean and sod crops.

	Pounds of seed cotton per acre					
	1st-year cotton		2nd-year cotton		3rd-year cotton	
Treatment	1961	1962	1962	1963	1963	Average
Cotton each year	1610	855	859	1390	1507	1244
1 year in corn	1669	653	895	1435	1897	1310
2 years in corn	1406	610	980	1415	1853	1253
3 years in corn	1238	729	945	1624	1996	1306
4 years in corn	1269	848	951	1579	1945	1318
Corn average	1396	710	943	1513	1921	1297
1 year in soybeans	2181	804	1005	1265	1748	1401
2 years in soybeans	1948	819	900	1178	1897	1348
3 years in soybeans	1839	861	879	1292	1576	1289
4 years in soybeans	2134	821	933	1148	1746	1356
Soybean average	2026	826	929	1221	1742	1349
1 year in sod	1713	652	888	1527	1754	1307
2 years in sod	978	854	830	1640	1736	1208
3 years in sod	708	399	790	1202	1941	1008
4 years in sod	220	363	733	1344	1864	905
Sod average	905	567	810	1428	1824	1107

Appendix Table 6. The effect of 1, 2, 3 and 4 years of corn, soybean and sod crops on the water-stable aggregates of a Dubbs silt loam soil as measured during subsequent cotton crops.

	Percent water-stable aggregates*				
	1st-year cotton		2nd-year cotton	3rd-year cotton	
Treatment	1960	1962	1962	1962	Average
Cotton each year	14.8	12.6	12.0	21.4	15.2
1 year in corn	15.2	14.4	17.8	21.4	17.2
2 years in corn	16.8	13.0	18.0	25.0	18.2
3 years in corn	13.6	17.2	14.0	25.0	17.5
4 years in corn	19.2	12.4	15.6	27.4	18.7
Corn average	16.2	14.3	16.4	24.7	17.9
1 year in soybeans	18.8	13.4	12.6	19.0	16.0
2 years in soybeans	11.2	8.0	11.2	17.0	12.3
3 years in soybeans	11.6	9.2	10.0	17.8	12.2
4 years in soybeans	18.4	11.0	13.2	22.0	16.2
Soybean average	15.0	10.4	11.8	18.9	14.0
1 year in sod	15.0	9.6	15.0	14.4	13.5
2 years in sod	15.4	12.6	11.2	18.0	14.3
3 years in sod	21.4	15.4	12.2	19.8	17.2
4 years in sod	18.2	18.4	15.4	22.6	18.7
Sod average	17.5	14.0	13.5	18.7	15.9

*Average of 2 and 5 minute oscillations.

Appendix Table 7. The effect of 1, 2, 3 and 4 years of corn, soybean and sod crops on the bulk density of a Dubbs silt loam soil as measured during subsequent cotton crops.

	Bulk density						
	1st-year cotton			2nd-year cotton		3rd-year cotton	
Treatment	1960	1961	1962	1961	1962	1962	Average
Cotton each year	1.30	1.36	1.29	1.38	1.31	1.34	1.33
1 year in corn	1.30	1.35	1.31	1.37	1.33	1.27	1.32
2 years in corn	1.25	1.36	1.31	1.33	1.34	1.29	1.31
3 years in corn	1.27	1.36	1.31	1.32	1.34	1.29	1.32
4 years in corn	1.26	1.34	1.29	1.36	1.31	1.30	1.31
Corn average	1.27	1.35	1.31	1.35	1.33	1.29	1.32
1 year in soybeans	1.31	1.33	1.31	1.34	1.31	1.31	1.32
2 years in soybeans	1.30	1.39	1.29	1.35	1.31	1.32	1.33
3 years in soybeans	1.31	1.32	1.31	1.31	1.31	1.32	1.31
4 years in soybeans	1.30	1.34	1.28	1.33	1.32	1.33	1.32
Soybean average	1.31	1.35	1.30	1.33	1.31	1.32	1.32
1 year in sod	1.28	1.28	1.29	1.38	1.31	1.32	1.31
2 years in sod	1.24	1.29	1.31	1.38	1.30	1.32	1.31
3 years in sod	1.28	1.34	1.32	1.32	1.30	1.31	1.31
4 years in sod	1.28	1.34	1.32	1.31	1.30	1.31	1.31
Sod average	1.27	1.31	1.31	1.35	1.30	1.32	1.31

Appendix Table 8. The effect of 1, 2, 3 and 4 years of corn, soybeans and sod crops on the available P_2O_5 of a Dubbs silt loam soil as measured during subsequent cotton crops.

	Pounds per acre of available P_2O_5						
	1st-year cotton			2nd-year cotton		3rd-year cotton	
Treatment	1960	1961	1962	1961	1962	1962	Average
Cotton each year	156	109	113	162	150	192	147
1 year in corn	159	90	111	144	123	206	139
2 years in corn	222	87	127	203	114	242	166
3 years in corn	222	71	104	226	114	228	161
4 years in corn	162	66	114	179	103	206	138
Corn average	191	79	114	188	113	220	151
1 year in soybeans	127	99	116	133	134	151	127
2 years in soybeans	118	93	116	121	125	155	121
3 years in soybeans	113	91	117	127	124	150	120
4 years in soybeans	111	92	106	132	124	151	119
Soybean average	117	94	114	128	127	152	122
1 year in sod	162	131	153	149	158	174	155
2 years in sod	138	108	127	135	132	167	135
3 years in sod	121	106	106	122	142	141	123
4 years in sod	118	97	105	127	124	171	124
Sod average	135	111	123	133	139	163	134

Appendix Table 9. The effect of 1, 2, 3 and 4 years of corn, soybean and sod crops on the exchangeable potassium of a Dubbs silt loam soil as measured during subsequent cotton crops.

	Pounds per acre of exchangeable potassium						
	1st-year cotton			2nd-year cotton		3rd-year cotton	
Treatment	1960	1961	1962	1961	1962	1962	Average
Cotton each year	426	259	328	337	324	378	342
1 year in corn	438	248	327	339	303	419	346
2 years in corn	500	266	338	460	309	422	383
3 years in corn	495	236	329	420	325	456	377
4 years in corn	464	235	321	384	312	465	364
Corn average	474	246	329	401	312	441	367
1 year in soybeans	411	246	337	316	293	343	324
2 years in soybeans	384	229	314	303	274	427	322
3 years in soybeans	398	229	329	309	282	348	316
4 years in soybeans	391	234	339	307	282	329	314
Soybean average	396	235	330	309	283	362	319
1 year in sod	419	315	366	334	432	452	386
2 years in sod	431	338	369	339	403	427	385
3 years in sod	436	378	386	339	427	395	394
4 years in sod	502	389	367	377	358	403	399
Sod average	447	355	372	347	405	419	391

Appendix Table 10. The effect of 1, 2, 3 and 4 years of corn, soybean and sod crops on the organic matter content of a Dubbs silt loam soil as measured during subsequent cotton crops.

	Percent organic matter						
	1st-year cotton			2nd-year cotton		3rd-year cotton	
Treatment	1960	1961	1962	1961	1962	1962	Average
Cotton each year	1.17	0.95	0.99	1.17	0.96	1.00	1.04
1 year in corn	1.08	0.95	1.21	1.21	0.92	1.00	1.06
2 years in corn	1.18	0.96	1.13	1.18	0.95	1.21	1.10
3 years in corn	1.15	0.92	1.28	1.18	1.09	1.05	1.11
4 years in corn	1.12	1.05	1.09	1.20	1.05	1.15	1.11
Corn average	1.13	0.97	1.18	1.19	1.00	1.10	1.10
1 year in soybeans	1.02	0.95	1.08	1.05	0.89	0.98	1.00
2 years in soybeans	0.90	0.93	1.08	1.08	0.89	0.95	0.97
3 years in soybeans	1.11	0.94	1.02	1.15	0.98	1.05	1.04
4 years in soybeans	1.08	1.02	1.12	1.08	0.95	1.02	1.05
Soybean average	1.03	0.96	1.08	1.09	0.93	1.00	1.02
1 year in sod	1.12	1.28	1.24	1.18	0.93	1.08	1.14
2 years in sod	1.02	1.08	1.32	1.32	1.02	1.11	1.15
3 years in sod	1.19	1.05	1.31	1.20	0.95	1.08	1.13
4 years in sod	1.18	1.11	1.28	1.34	1.02	1.05	1.16
Sod average	1.13	1.13	1.29	1.26	0.98	1.08	1.15

Appendix Table 11. The effect of 1, 2, 3 and 4 years of corn, soybean and sod crops on the pH of a Dubbs silt loam soil as measured during subsequent cotton crops.

	Soil pH					
	1st-year cotton		2nd-year cotton		3rd-year cotton	
Treatment	1961	1962	1961	1962	1962	Average
Cotton each year	6.1	6.1	6.2	6.0	6.0	6.1
1 year in corn	6.0	6.1	6.2	5.8	6.0	6.0
2 years in corn	6.1	6.1	6.4	5.9	6.1	6.1
3 years in corn	5.9	6.0	6.4	6.0	6.3	6.1
4 years in corn	5.8	5.9	6.2	6.0	6.0	6.0
Corn average	6.0	6.0	6.3	5.9	6.1	6.1
1 year in soybeans	6.2	6.1	6.2	5.7	6.0	6.0
2 years in soybeans	6.1	6.1	6.1	6.0	5.7	6.0
3 years in soybeans	6.1	5.9	6.0	5.9	5.9	6.0
4 years in soybeans	6.1	6.1	6.2	6.0	6.0	6.1
Soybean average	6.1	6.1	6.1	5.9	5.9	6.0
1 year in sod	6.6	6.2	6.3	6.4	6.3	6.4
2 years in sod	6.1	6.4	6.1	6.0	5.9	6.1
3 years in sod	6.1	6.5	6.1	6.1	6.0	6.2
4 years in sod	6.1	6.4	6.1	5.7	5.8	6.0
Sod average	6.2	6.4	6.2	6.0	6.0	6.2

Appendix Table 12. The effect of 1, 2, 3 and 4 years of corn, soybean and sod crops on the pH, available P_2O_5 and organic matter content of a Sharkey clay soil as measured during the 1962 cotton crop.

	Soil pH		Lbs/A available P_2O_5		Percent organic matter	
Treatment	1st-year cotton	2nd-year cotton	1st-year cotton	2nd-year cotton	1st-year cotton	2nd-year cotton
Cotton each year	6.2	6.0	162	170	1.93	2.29
1 year in corn	6.2	6.2	177	199	2.07	2.34
2 years in corn	6.3	6.1	163	162	1.92	1.80
3 years in corn	6.2	6.1	173	178	1.90	2.17
4 years in corn	6.3	6.2	168	167	1.99	2.15
Corn average	6.3	6.2	170	176	1.97	2.12
1 year in soybeans	6.2	5.9	184	181	2.18	2.15
2 years in soybeans	6.2	6.0	184	205	2.14	2.43
3 years in soybeans	6.2	6.0	171	209	1.84	2.39
4 years in soybeans	6.3	5.9	174	197	1.98	2.39
Soybean average	6.2	6.0	178	198	2.04	2.34
1 year in sod	6.3	6.2	182	175	1.96	2.07
2 years in sod	6.4	6.0	172	169	2.14	2.22
3 years in sod	6.4	6.3	181	170	2.34	2.34
4 years in sod	6.4	5.9	169	157	2.18	2.33
Sod average	6.4	6.1	176	168	2.16	2.24

BULLETIN 711 JULY 1965

Mississippi County Population Estimates 1960 - 1964

By ELLEN S. BRYANT

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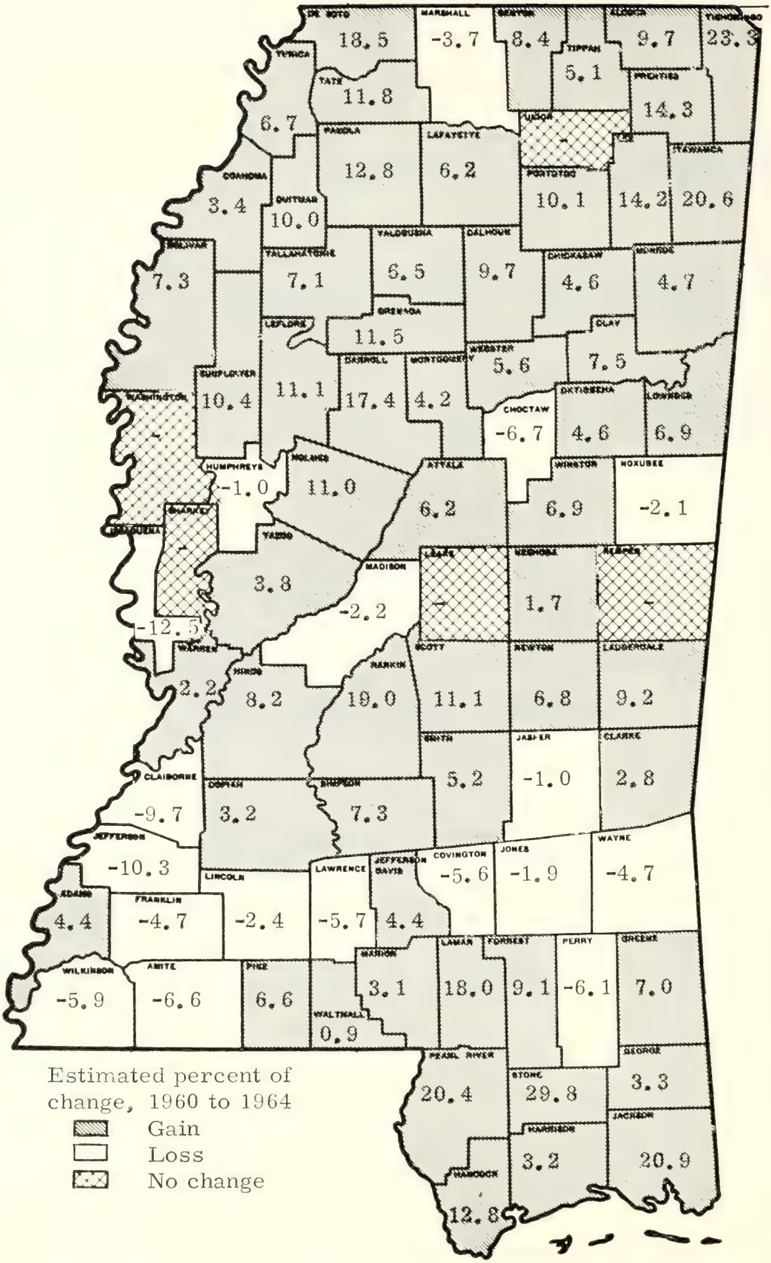
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CARROLL 17.4
MONTGOMERY 4.2
WASHINGTON -
CHOCTAW -6.7
OKTIBBEHA 4.6
LOWNDES 6.9
HUMPHREYS -1.0
HOLMES 11.0
ATTALA 6.2
WINSTON 6.9
NOXUBEE -2.1
SHARKEY -
ISSAQUENA -12.5
YAZOO 3.8
MADISON -2.2
LEAKE -
NESHOBA 1.7
KEMPER -
WARREN 2.2
HINDS 8.2
RANKIN 19.0
SCOTT 11.1
NEWTON 6.8
LAUDERDALE 9.2
CLAIBORNE -9.7
COPIAH 3.2
SIMPSON 7.3
SMITH 5.2
JASPER -1.0
CLARKE 2.8
JEFFERSON -10.3
LINCOLN -2.4
LAWRENCE -5.7
JEFFERSON DAVIS 4.4
COVINGTON -5.6
JONES -1.9
WAYNE -4.7
ADAMS 4.4
FRANKLIN -4.7
MARION 3.1
LAMAR 18.0
FORREST 9.1
PERRY -6.1
GREENE 7.0
WILKINSON -5.9
AMITE -6.6
PIKE 6.6
WALTHALL 0.9
PEARL RIVER 20.4
STONE 29.8
GEORGE 3.3
HARRISON 3.2
JACKSON 20.9
HANCOCK 12.8
Estimated percent of change, 1960 to 1964
▨ Gain
☐ Loss
⊠ No change

Estimated population growth of Mississippi counties 1960 to 1964.

Mississippi County Population Estimates 1965

BY ELLEN S. BRYANT

Mississippi's population increased by an estimated additional 26 thousand persons between July of 1963 and July of 1964, augmenting the state's net numerical increase since the 1960 Census was taken to nearly 138 thousand persons. This increment represents a growth of 6.3 percent in four years and is very close to the estimated 6.7 percent national increase over the same period.[1]

The 1964 county estimates of Mississippi population set the state total at 2,315,900; the white total at 1,370,400; and the nonwhite total at 945,500. Most of this growth, while essentially related to urban and industrial expansion, seems to be relatively well dispersed throughout the state. Seventy-three of the state's 82 counties are indicated as having experienced either total, or white, or nonwhite growth since 1960. The white to nonwhite growth ratio was better than four to one over the last estimate year and five to one over the four-year period.[2]

Sizeable growth has thus again been recorded for the population of Mississippi, particularly for the white segment. However, while the growth continues to be both sizeable and extensive, it has not been unvarying. As mid-decade approaches the surprisingly sharp increases of 1961 and 1962[3] seem to be levelling off into more conservative growth rates. Compared to the 25 thousand of estimated growth during the last estimating period, the 1962 to 1963 year showed a 32 thousand increase; that for 1961 to 1962 was 45 thousand; and between 1960 and 1961, 34 thousand were added. The latest increment is only about half that of the peak growth year.

Some explanation and support for the changing magnitude of population growth in the state can be had from an examinination of trends in the economy. For instance, nonagricultural employment expanded 4.2 percent in each of the 61-62 and 62-63 periods, while between 1963 and 1964 the growth in nonfarm jobs dropped to 3.7 percent. These figures suggest that the rate of expansion in population is related to the rate of labor force expansion, if one assumes the existence of flexible patterns of migration.

A contradictory note, however, was interjected by the 1960 to 1961 trends when high population growth was accompanied by a very minimal employment growth of 1.2 percent.[4] Population increments during this time were probably in part the indirect result of cutbacks in the national economy which probably stifled outmovement and triggered return migration from outside the state among those left jobless.[5] The more recent, but reduced population growth, which seems to be tied to a more substantial economic growth, would seem to offer a sounder basis for progress in the state and a more desirable situation than population growth which is not accompanied by sufficient economic expansion.

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[1] U. S. Bureau of the Census, "Population Estimates," **Current Population Reports**, Series P-25, No. 294 (November 5, 1964).

[2] These estimates were computed by the vital rates method as developed by Donald J. Bogue. For an explanation of the procedures see Mississippi Experiment Station Bulletin No. 693, July, 1964.

[3] See Ellen S. Bryant, **Estimated Population Trends, Mississippi 1960-61**, Bulletin 659. State College: Mississippi State University Agricultural Experiment Station, February, 1963.

[4] Compare statistics in the Annual Supplements of **Mississippi Labor Market**, Volume XIV (March, 1963), No. 2 and Vol. XVI (March, 1965), No. 2, published by Mississippi Employment Security Commission.

The spread of growth in the state seems to have been more inclusive in 1964 than it was in 1961. At the earlier date, 45 counties indicated net population increases, many of them for the first time since before 1950.[6] The latest estimates indicate that 59 counties have had total net growth since 1960, and that an additional 26 counties, while not recording total growth increased either their white or nonwhite components. Figure 1 shows the distribution of growth in the counties and the estimated rates of total net change.

Race Differentials—Natural Increase and Migration

The estimated lag in nonwhite growth, which is serving to continuously reduce the proportion of nonwhites in the state's population, is accounted for entirely by drastic migration differentials between the two races. The natural increase for the nonwhite population is far in excess of that for the white segment and unless large proportions move out their increases would sizeably outstrip white growth.

Nonwhite births averaged an estimated 32 per thousand in the state in 1964 as compared to an estimated 19 per thousand for the whites.[7] The death rate differential was about two percent higher for the nonwhite population (11.0 as compared to 8.8 per thousand). The resulting natural increase (births minus deaths) for nonwhites in 1964 was approximately 20 thousand as compared to 14 thousand for whites.

The third column of Table 1 gives the state's recorded natural increase by race over the whole four-year period.

Table 1 also gives the estimated net migration which, given the data on natural increase, had to accompany the differential white and nonwhite growth rates. It can be seen from this table that 72 percent of the amount of nonwhite net natural increase was lost to other states through out-migration between 1960 and 1964. Also, during the same period, more than 48 thousand white in-migrants, an equivalent of 74 percent of the white natural increase, were added to the state's population. The resultant net loss of 15 thousand migrants was less than one percent of the total expected 1964 population. The resultant change in population composition yielded a further reduced proportion of nonwhites in Mississippi—an estimated 40.8 percent as compared to the 42.3 percent reported in the 1960 U. S. Census enumeration.

Local Variations

Although some type of population growth has been measured in 73 of Mississippi's counties, size of growth and range in rates of change among the counties vary considerably. These variations in rates of growth arrange themselves in patterns which indicate that population growth in the state is of urban, dispersed industrial, or suburban types.

Largest Growth: Table 2 lists the counties which have registered the highest numerical increases since 1960. In terms of relevance for the state as a whole, it is the growth in these counties with

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[5] Bryant, **op. cit.**

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[6] Ibid.

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[7] Both numbers of births and estimated birth rates for both races were down in 1964, the latest estimate period. Nonwhite rates have declined from 35 per thousand in 1960 and white rates from 22.6. In numbers, nonwhite births are down from 32,100 to 30,600 and white births from 27,600 to 25,900. See the annual bulletins of **Vital Statistics**, issued by the Mississippi State Board of Health for years sited.

Table 1. Estimated net migration, Mississippi, April 1, 1960 to July 1, 1964.

Mississippi population	1960 population	Natural increase	Total expected population*	Estimated ave. 1964 population	Estimated net migration**
Total	2,178,141	152,474	2,330,615	2,315,900	—14,715
White	1,257,546	64,778	1,322,324	1,370,400	48,076
Nonwhite	920,595	87,696	1,008,291	945,500	—62.791

Data Source: U. S. Bureau of the Census and Mississippi State Board of Health.

*Column 1 plus column 2.

**Column 4 minus column 3.

large numerical increments which is probably most significant. These counties (roughly 18 percent) have accumulated 65 percent of the state's estimated four-year growth. Included in the list are all counties having a total growth of more than three thousand inhabitants, a white growth of more than three thousand, and a nonwhite growth of two thousand or over. From the table it is apparent that significant numerical growth is occurring chiefly (1) in the white population, (2) in counties with sizeable urban complexes, (3) in those adjacent to growing urban areas. or (4) where new industrial centers are developing.

Hinds County, the most populous and urbanized in the state, had the largest growth of any county although its percent of growth was a moderate 8.2 percent, only two points higher than the state average. Jackson County on the Gulf Coast had the next largest population increment, gaining nearly 12 thousand persons in the same period. Jackson County's growth also represented one of the highest rates of growth in the state. It seems, in fact, to be outstripping adjoining Harrison County (the second largest in the state populationwise) in both rate and number increments. Jackson County's growth may be partly a suburban spill-over from Harrison County; however, highly urban, it seems to be also experiencing sizeable economic growth of its own. According to employment statistics in Mississippi Economic Security Commission reports, employment in Jackson County increased 25 percent in the first three years of the decade and continued at about this rate into 1964.[8] Furthermore it had a median family income in 1960 of $5120, the highest in the state. Hinds was second with $4783, and Harrison third with $4272.[9]

Three of the counties included in the table indicate a need for close examination of reasons for their growth. Growth in these counties—De Soto, Tishomingo, and Itawamba—is more difficult to explain. They were all classed as completely rural in 1960, containing not a single population center as large as 2500 persons.[10] In view of their rural nature their estimated growth since 1960 is surprising. In addition to having high numerical growth, rates of increment since 1960 were some of the highest in the state. In the order listed they ranked seventh, second, and fourth in proportional increases. De Soto County furthermore, had the highest rate of white growth in the state—an estimated 53.7 percent since

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[8] Mississippi Economic Security Commission, **Jobs Index,** Vol. XXV (First Quarter, 1962), No. 1; Vol. XXV (Third Quarter, 1962), No. 3; Vol. XXVI (Third Quarter, 1963), No. 3; **idem., Quarterly Bulletin on Employment and Wages on Workers Covered by the Mississippi Employment Security Law** (First Quarter, 1964); and (Second Quarter, 1964), **Passim.**

[9] U. S. Bureau of the Census, **U. S. Census of Population: 1960, Mississippi.** Final Report PC(1)-26C. Washington, D. C.: U. S. Government Printing Office, 1961, Table 35.

[10] U. S. Bureau of the Census, **U. S. Census of Population: 1960, Mississippi.** Final Report PC(1)-26A. Washington, D. C.: U. S. Government Printing Office, 1960, Table 6.

1960.

At least part of the explanation seems to be geographical since it is probably not a coincidence that each of these counties is located adjacent to counties with existing, sizeable industrial complexes. In 1960, 28 percent of the workers in De Soto County, 26 percent in Itawamba and 16 percent in Tishomingo worked outside their county of residence. The state average was 8.6 percent.[11] De Soto County is directly south of Shelby County and Memphis, Tennessee. Tishomingo is just west of Lauderdale and Colbert Counties in Alabama where the Florence, Sheffield and Tuscumbia industrial complexes are located. Itawamba County, just south of Tishomingo, is adjacent to Lee County and Tupelo, a rapidly industrializing county in Mississippi, and like Tishomingo, is also within easy access to the Florence-Sheffield-Tuscumbia area.

It is not improbable that part of the rapid population growth of these three counties is tied to employment in the nearby urban areas. However, nonfarm employment growth within the counties seems also to have been a factor. Average monthly employment figures for 1963, the latest yearly averages available at this writing, indicate an increase since 1960 of 75 percent for De Soto, 24 percent for Itawamba, and 19 percent for Tishomingo. These percents compare with a state average of nine percent and can be described as rapid employment increases. Thus, in addition to serving a suburban function, these counties are probably also part of a trend toward industrial dispersion from and around large industrial regions to nearby lower density areas—a trend which seems to have been made possible by improved road systems.

Two other counties, whose estimated growth since 1960 is rather surprising, are Sunflower and Bolivar, where percent urban at the time of the Census enumeration was only about 15 and 19 percents respectively.[12] These counties indicate total growths of about five and four thousand of which more than three-fifths of the first and three-fourths of the second was nonwhite. Again an examination of employment statistics indicates that new industrial development may be the casual factor involved. In Sunflower county, population growth was accompanied by about 14 percent increase in nonagricultural employment between 1960 and 1963. In Bolivar, the employment rise over the same period was 8.5 percent. Partial data on 1964 employment for Bolivar indicate that in the first half of 1964 employment was 5 percent greater than in the same period of 1963.

Most of the other counties listed—Lauderdale, Lee, Leflore, Forrest, Lowndes, and Rankin—either contain well established urban centers or are adjacent to counties with large centers and their growth is not surprising. There seems to be a relatively well established tenet in population growth in Mississippi that growth begets growth. The increase in Pearl River County, site of the NASA test installation, was also expected.

Rapid Rates of Growth: Table 3 lists counties with highest total, white, and nonwhite growth rates. Many of the counties listed in Table 2 also appear in this list. Noticeable in their absence are Hinds, Lauderdale and Harrison counties, indicating again that it is well to be cautious in attaching significance to rapid rates which do not also represent sizeable numerical increases. Small fluctuations may look big percentagewise. The growth in the high rate counties seems also to fall into the same patterns

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[11] U. S. Bureau of the Census, Final Report PC(1)-26C, Table 36.

[12] U. S. Bureau of the Census, Final Report PC(1)-26A, Table 6, passim.

Table 2. Counties showing largest estimated population increments, 1960 to 1964, for total, white, and nonwhite populations.

	Net Growth (in 000's)		
County	Total	White	Nonwhite
Hinds	15.3	10.3	5.0
Jackson	11.6	9.7	1.9
Rankin	6.5	3.7	2.8
Lauderdale	6.1	5.2	0.9
Lee	5.8	5.4	0.3
Leflore	5.3	3.4	1.9
Forrest	4.8	3.9	1.0
Sunflower	4.7	1.7	3.1
Pearl River	4.5	4.3	0.2
De Soto	4.4	5.0	—0.5
Bolivar	4.0	1.2	2.7
Harrison	3.8	2.7	1.1
Panola	3.7	1.6	2.1
Lowndes	3.2	4.0	—0.8
Tishomingo	3.2	3.2	—
Itawamba	3.1	3.0	0.1

Table 3. Ten fastest growing counties, 1960 to 1964, as estimated for total, white and nonwhite populations.

Total		White		Nonwhite	
County	Percent Increase	County	Percent Increase	County	Percent Increase
Stone	30	De Soto	54	Lamar	27
Tishomingo	23	Tunica	44	Pontotoc	27
Jackson	21	Carroll	39	Benton	23
Itawamba	20	Stone	33	Rankin	22
Pearl River	20	Pearl River	25	Stone	19
Rankin	19	Tishomingo	24	Winston	18
De Soto	19	Jackson	22	Perry	18
Lamar	18	Itawamba	21	Jackson	18
Carroll	17	Leflore	21	Webster	17
Prentiss	14	Holmes	20	Itawamba	16

as noted in the preceding analysis. Several of them seem to be growing as a result of their geographical location next to highly urbanized centers. Stone County, which is directly north of Harrison and east of Pearl River, sustained the highest net growth in the state in 1964 after a recorded 1963 dip in the white population. It is interesting that all of the counties contiguous with Harrison County had rates of growth considerably higher than Harrison itself. The suggestion of suburbanization is strong. Part of the growth in Stone may, of course, correlate with the development of Pearl River's test center, as may its estimated drop in 1963. Growth in employment within Stone between 1960 and 1963 amounted to 15 percent; in Harrison it was 13 percent; in Pearl River, 2 percent.

The high growth rate in Carroll County can only be explained by suburban growth from adjoining Leflore County and Greenwood. The county indicates no increase in employment since 1960. In Lamar County increases may also be suburban in nature since the county is adjacent to Forrest County which contains Hattiesburg. However employment increments here amounted to 13 percent by 1963 and, in addition, the numerical growth is not impressive. Its heavy nonwhite growth represents an estimated increase of only about 600 people. Prentiss County, whose growth seems to consist almost entirely of whites, had had the substantial employment growth of 22 percent by 1963. It is also, of course, sandwiched between growing Lee, Tishomingo, and Itawamba counties, and had about 12 percent of its workers employed outside the county in 1960. Tunica's impressive white growth rate represents an increase of less than 1500 persons. Its growth may also be chiefly tied to the start of a suburban development since its employment increase by 1963 was only 8 percent. Holmes County white growth, though high in percent, is relatively low in numbers and is supported by a 28 percent growth in employment.

Nonwhite Growth: Lamar, Pontotoc, and Benton counties, which top the list in rates of nonwhite growth, actually increased only by roughly 1,000 persons each. Stone, Webster, Perry, and Itawamba increased only by a few hundred each. Only Rankin and Jackson reached close to or above the 2,000 growth level. Winston had somewhat less than these with about 1500 added nonwhites. It is interesting that of the ten counties with rapid nonwhite increases all but three had nonwhite proportions in 1960 ranging between 6 and 25 percent. Rankin, Benton, and Winston counties exceeded this level, and only the latter two reached the state average. Significant nonwhite growth is largely confined to Hinds, Sunflower, Rankin, Bolivar, Panola, and Jackson counties, only two of which also manifested high rates of growth.

Nongrowth: A few Missisippi counties were more noticeable for nongrowth than growth. Jones County, highly urban and site of Laurel, is perhaps most obviously so, having recorded net loss and only nonwhite increases since the decade began. An examination of the employment trends supports the estimated decline in population. Jobs had decreased nearly 8 percent by 1963 and continued to do so at an even faster rate in 1964. The upset in adjacent Covington County's earlier growth trend may be tied to conditions in Jones County.

Lauderdale County while recording net and sizeable growth since 1960 has displayed irregular growth patterns. Interestingly, this irregularity is also reflected in employment variations. Similarly Noxubee's reversal from growth to loss is reflected in employment losses in the last two years. Washington County, apparently suffering earlier from a loss of military personnel, seems to be recovering its growth trend.

Summary and Implications

Population growth is continuing in Mississippi at somewhat reduced, but substantial rates as the state moves closer to the national pattern of rural-urban distributions. The estimated growth, while relatively well distributed over the state, is essentially a result of movement into urbanized and industrializing areas. Thus the growth does not simply represent an accumulation of surplus population, but seems to be tied to a healthy and seemingly adequate industrial growth. White growth has been impressive and while the estimated white in-migration may be surprising on the surface, it is a logical complement of industrialization and urbanization with their increasing demands for a labor force with new types of technological and organizational skills. The limited growth of the nonwhite population resulting from reduced outmigration rates in the new decade seems also to be of an industrial-urban nature, and most of the counties in the state are experiencing at least a minimal nonwhite growth. However sizeable nonwhite growth is limited to about six counties.

Table 4. Estimated population and percent of change of Mississippi Counties by race, 1961 thru 1964

	1964	1963	1962	1961	1960**	Pct. of Change 60-64	Pct. of Change 50-60**
Mississippi	2,315,900	2,290,180	2,258,140	2,212,580	2,178,141	6.3	— —
White	1,370,400	1,348,880	1,321,140	1,284,660	1,257,546	9.0	5.8
Nonwhite	945,500	941,300	936,990	927,920	920,595	2.7	—7.0
Adams	39,390	37,520	38,570	37,520	37,730	4.4	17.0
White	20,390	18,560	19,340	18,860	19,035	7.1	17.8
Nonwhite	19,000	18,960	19,230	18,660	18,695	1.6	16.1
Alcorn	27,740	26,840	27,300	26,120	25,282	9.7	—6.9
White	24,550	23,380	23,930	22,760	21,949	11.9	—10.0
Nonwhite	3,190	3,460	3,370	3,350	3,333	—4.3	—14.6
Amite	14,550	17,100	15,320	14,920	15,573	—6.6	—19.1
White	6,940	8,150	6,940	6,780	7,130	—2.7	—19.2
Nonwhite	7,610	8,950	8,380	8,130	8,443	—9.9	—19.1
Attala	22,650	22,520	20,650	22,080	21,335	6.2	—19.9
White	13,050	13,420	11,840	12,620	11,789	10.7	—21.8
Nonwhite	9,600	9,100	8,810	9,460	9,546	0.6	—17.5
Benton	8,370	8,160	7,800	7,980	7,723	8.4	—12.2
White	3,920	3,710	4,260	4,590	4,114	—4.7	—16.8
Nonwhite	4,450	4,450	3,540	3,400	3,609	23.3	—6.3
Bolivar	58,430	57,620	56,330	56,950	54,464	7.3	—13.6
White	18,750	19,570	18,880	17,600	17,521	7.0	—11.8
Nonwhite	39,680	38,050	37,540	39,350	36,943	7.4	—14.4
Calhoun	17,480	16,630	16,390	16,840	15,941	9.7	—13.2
White	13,020	12,840	11,910	12,300	11,595	12.3	—17.6
Nonwhite	4,460	3,790	4,480	4,540	4,346	2.6	1.3
Carroll	13,120	12,030	13,190	11,770	11,177	17.4	—27.9
White	6,480	5,550	6,270	5,020	4,677	38.6	—29.8
Nonwhite	6,640	6,480	6,920	6,750	6,500	2.2	—26.4
Chickasaw	17,670	17,610	17,720	16,850	16,891	4.6	—10.9
White	10,980	10,620	10,270	10,380	10,380	5.8	— 1.4
Nonwhite	6,690	6,990	6,970	6,580	6,511	2.7	—22.7
Choctaw	7,860	7,850	8,500	8,320	8,423	— 6.7	—23.5
White	5,660	5,310	6,240	5,890	5,903	—4.1	—23.1
Nonwhite	2,200	2,540	2,260	2,420	2,520	—12.7	—24.3
Claiborne	9,790	9,800	10,250	10,660	10,845	— 9.7	— 9.2
White	2,670	2,840	2,720	2,660	2,600	2.3	—13.6
Nonwhite	7,120	6,960	7,530	8,010	8,245	—13.6	— 7.7
Clarke	16,960	17,070	15,550	15,990	16,493	2.8	—14.8
White	11,250	11,580	9,120	9,710	10,001	12.5	—12.9
Nonwhite	5,710	5,490	6,430	6,280	6,492	—12.0	—17.6
Clay	20,360	19,760	19,200	19,210	18,933	7.5	6.6
White	9,300	9,980	7,920	8,980	9,214	1.0	20.3
Nonwhite	11,060	9,780	11,280	10,230	9,719	13.8	— 3.7
Coahoma	47,780	48,500	49,620	48,980	46,212	3.4	— 6.4
White	16,040	15,160	16,140	16,110	14,630	9.6	6.8
Nonwhite	31,740	33,340	33,480	32,880	31,582	0.5	—11.4
Copiah	27,930	27,250	27,790	27,320	27,051	3.2	—11.3
White	13,450	12,790	12,910	13,550	12,992	3.5	— 8.6
Nonwhite	14,480	14,460	14,880	13,780	14,059	3.0	—13.7
Covington	12,880	16,190	14,270	13,690	13,637	— 5.6	—15.0
White	8,620	10,740	9,360	8,960	8,896	— 3.1	—17.8
Nonwhite	4,260	5,450	4,910	4,730	4,741	—10.1	— 9.1
De Soto	28,310	27,310	24,330	24,650	23,891	18.5	— 2.9
White	14,210	12,710	10,890	9,730	9,248	53.7	14.5
Nonwhite	14,100	14,600	13,440	14,920	14,643	— 3.7	—11.4
Forrest	57,540	56,590	55,550	56,250	52,722	9.1	17.0
White	41,840	41,770	40,270	40,830	37,970	10.2	18.3
Nonwhite	15,700	14,820	15,280	15,420	14,752	6.4	13.8
Franklin	8,850	9,230	9,720	9,430	9,286	— 4.7	—15.0
White	5,400	5,710	5,750	5,580	5,486	— 1.6	—17.2
Nonwhite	3,450	3,520	3,970	3,840	3,800	— 9.2	—11.7
George	11,460	11,130	11,120	11,480	11,098	3.3	10.8
White	10,200	9,450	9,540	10,230	9,811	4.0	11.7
Nonwhite	1,260	1,680	1,580	1,250	1,287	2.1	4.5

Table 4 Continued: Estimated population and percent of change of Mississippi Counties.

	1964	1963	1962	1961	1960**	Pct. of Change 60-64	Pct. of Change 50-60**
Greene	8,950	8,350	8,320	8,170	8,366	7.0	— 1.8
White	6,930	6,780	6,420	6,340	6,443	7.6	— 4.0
Nonwhite	2,020	1,570	1,900	1,830	1,923	5.0	27.9
Grenada	20,520	19,120	19,030	19,620	18,409	11.5	— 2.2
White	11,230	10,320	10,230	10,160	9,352	20.1	3.9
Nonwhite	9,290	8,800	8,800	9,460	9,057	2.6	— 7.9
Hancock	15,830	16,100	14,920	14,760	14,039	12.8	18.1
White	13,450	13,140	12,110	12,440	11,784	14.1	19.6
Nonwhite	2,380	2,960	2,810	2,330	2,255	5.5	10.6
Harrison	123,270	125,390	130,070	118,390	119,489	3.2	42.1
White	102,970	105,210	109,700	99,840	100,233	2.7	41.9
Nonwhite	20,300	20,180	20,370	18,550	19,256	5.4	43.5
Hinds	202,350	199,680	198,680	189,840	187,045	8.2	31.6
White	122,500	117,020	115,540	112,440	112,205	9.2	43.4
Nonwhite	79,850	82,660	83,140	77,400	74,840	6.7	17.1
Holmes	30,070	27,040	25,700	28,300	27,096	11.0	—18.6
White	9,140	7,860	7,170	7,620	7,595	20.3	—13.9
Nonwhite	20,930	19,180	18,530	20,680	19,501	7.3	—20.3
Humphreys	18,910	19,380	19,220	19,500	19,093	— 1.0	—17.4
White	6,070	6,090	6,260	5,860	5,758	5.4	—17.9
Nonwhite	12,840	13,290	12,960	13,730	13,335	— 3.7	—17.2
Issaquena	3,200	2,690	2,350	3,080	3,576	—12.5	—28.0
White	1,140	850	690	1,280	1,176	— 3.1	—27.3
Nonwhite	2,060	1,840	1,660	1,800	2,400	—14.2	—28.3
Itawamba	18,190	17,350	15,590	14,700	15,080	20.6	—12.4
White	17,180	16,430	14,640	13,780	14,206	20.9	—12.7
Nonwhite	1,010	920	950	910	874	15.6	— 6.7
Jackson	67,100	66,990	62,930	57,330	55,522	20.9	76.8
White	54,340	55,350	50,760	46,180	44,658	21.7	81.1
Nonwhite	12,760	11,640	12,170	11,150	10,864	17.5	61.3
Jasper	16,740	17,130	19,640	17,340	16,909	— 1.0	—10.6
White	8,610	9,030	10,190	8,750	8,402	2.5	8.6
Nonwhite	8,130	8,100	9,450	8,590	8,507	— 4.4	—12.5
Jefferson	9,100	10,150	9,750	10,640	10,142	—10.3	—10.3
White	2,390	3,250	3,280	2,730	2,489	— 4.0	—13.8
Nonwhite	6,710	6,900	6,470	7,910	7,653	—12.3	— 9.1
Jeff Davis	14,130	13,430	13,540	12,940	13,540	4.4	—12.6
White	6,270	6,800	5,900	5,950	6,126	2.4	—11.1
Nonwhite	7,860	6,630	7,640	6,990	7,414	6.0	—13.9
Jones	58,390	59,070	59,980	60,670	59,542	— 1.9	4.0
White	42,420	43,890	43,460	44,890	44,095	— 3.8	4.5
Nonwhite	15,970	15,180	16,520	15,780	15,447	3.4	— 2.9
Kemper	12,280	11,670	10,750	13,000	12,277	......	—22.8
White	4,270	4,900	4,320	5,350	4,828	—11.6	—25.3
Nonwhite	8,010	6,770	6,430	7,650	7,449	7.5	—21.0
Lafayette	22,680	22,170	21,250	22,550	21,355	6.2	— 6.3
White	15,240	14,710	14,140	15,590	14,110	8.0	— 4.1
Nonwhite	7,440	7,460	7,110	6,960	7,245	2.7	—10.4
Lamar	16,140	14,890	15,130	14,510	13,675	18.0	3.4
White	13,310	12,720	12,290	12,080	11,443	16.3	2.9
Nonwhite	2,830	2,170	2,840	2,430	2,232	26.8	6.0
Lauderdale	73,290	73,620	70,500	69,710	67,119	9.2	4.6
White	48,880	50,340	49,170	45,410	43,635	12.0	7.0
Nonwhite	24,410	23,280	21,330	24,300	23,484	4.9	0.4
Lawrence	9,630	9,360	9,840	9,630	10,215	— 5.7	—19.2
White	6,010	6,120	6,380	6,470	6,354	— 5.4	—19.4
Nonwhite	3,620	3,240	3,460	3,160	3,861	— 4.2	—18.9
Leake	18,650	17,390	19,570	17,960	18,660	......	—13.7
White	10,260	9,850	11,440	10,320	10,559	— 2.8	—15.2
Nonwhite	8,390	7,540	8,130	7,640	8,101	3.6	—11.6
Lee	46,360	44,340	41,330	41,560	40,589	14.2	6.2
White	35,660	32,670	30,330	31,460	30,300	17.7	9.9
Nonwhite	10,700	11,670	11,000	10,100	10,289	4.0	— 3.5

Table 4 Continued: Estimated population and percent of change of Mississippi Counties.

Leflore	52,450	48,100	48,100	48,430	47,142	11.1	— 9.0
White	20,140	17,400	18,210	18,200	16,699	20.6	1.3
Nonwhite	32,310	30,700	29,890	30,230	30,443	6.1	—13.8
Lincoln	26,130	26,170	28,180	27,120	26,759	— 2.4	— 4.1
White	18,870	18,230	20,140	18,610	18,407	2.5	— 1.6
Nonwhite	7,260	7,940	8,040	8,510	8,352	—13.1	— 9.1
Lowndes	49,860	52,500	50,200	47.790	46,639	6.9	23.2
White	32,860	33.520	31,990	29,910	28,871	13.8	48.5
Nonwhite	17,000	18,980	18,210	17,880	17,768	— 4.3	— 3.5
Madison	32,190	33,310	33,230	32.780	32,904	— 2.2	— 2.8
White	10,370	10,480	11,120	9,500	9,267	11.9	3.8
Nonwhite	21,820	22,830	22,110	23,280	23,637	— 7.7	— 5.2
Marion	24,010	21,440	23,470	24,540	23,293	3.1	— 2.8
White	15,100	13,840	14,920	16,550	15,408	— 2.0	— 1.1
Nonwhite	8,910	7,600	8,500	7,990	7,885	13.0	— 6.0
Marshall	23,600	25,120	25,020	24,250	24,503	— 3.7	— 2.4
White	8,130	7,550	7,550	7,130	7,264	11.9	— 1.5
Nonwhite	15,470	17,570	17,470	17,130	17,239	—10.3	— 2.8
Monroe	35,540	36,500	33,550	31,970	33,953	4.7	— 7.1
White	24.870	25.260	22,460	20,290	21.932	13.4	— 3.9
Nonwhite	10,670	11,240	11,090	11.680	12,021	—11.2	—12.3
Montgomery	13,880	13.350	15,020	15,130	13,320	4.2	— 7.9
White	8,690	8,080	9,280	8,380	7,349	18.2	—10.9
Nonwhite	5,190	5,270	5,740	6,780	5,971	—13.1	— 4.1
Neshoba	21,290	21,460	21,510	20,220	20,927	1.7	—18.7
White	15,770	15,800	16.210	14,930	15,026	5.0	—21.2
Nonwhite	5,520	5,660	5,300	5,290	5.901	— 6.5	—11.5
Newton	20,850	20.620	20.680	21,010	19,517	6.8	—14.0
White	14,100	13,700	14.420	14.670	12.950	8.9	—12.7
Nonwhite	6,750	6.920	6.260	5,340	6.567	2.8	—16.4
Noxubee	16,480	17,540	17,080	16,730	16,826	— 2.1	—16.0
White	4,430	5,130	4,620	5,000	4,724	— 6.2	— 7.7
Nonwhite	12,050	12,410	12,460	11,730	12,102	.....	—18.8
Oktibbeha	27,620	28,220	26,120	27,160	26,175	4.6	6.5
White	15,440	15,700	14,270	15,890	14,727	3.2	14.9
Nonwhite	12,180	12.520	11,850	11,270	11,448	6.4	— 2.6
Panola	32,470	31,220	31,590	29,230	28,791	12.8	— 7.9
White	14,130	14,130	13,580	12.660	12,565	12.5	— 8.8
Nonwhite	18,340	17.090	18,010	16,570	16,226	13.0	— 7.2
Pearl River	26,990	25,910	23,280	22.350	22,411	20.4	8.6
White	21,560	20,480	18,450	17,350	17,221	25.2	6.2
Nonwhite	5,430	5,430	5,830	5.010	5,190	4.6	15.5
Perry	8,210	8.530	8,140	8,120	8,745	— 6.1	— 4.0
White	5.370	5,820	6,100	6,110	6,333	—15.2	— 8.2
Nonwhite	2,840	2,710	2,040	2.010	2,412	17.7	9.1
Pike	37,370	34,870	35,820	36,290	35.063	6.6	.....
White	21,670	19,870	20,170	20.690	19,655	10.3	1.2
Nonwhite	15,700	15,000	15,650	15,610	15,408	1.9	— 1.9
Pontotoc	18,980	18,820	19,180	18,150	17,232	10.1	—13.8
White	14,820	15,360	15,620	14,960	13,946	6.3	—13.8
Nonwhite	4,160	3,460	3,560	3,190	3,286	26.6	—13.9
Prentiss	20,520	19.280	17,650	18.500	17,949	14.3	— 9.4
White	18,110	16,830	15,330	16,060	15,763	14.9	— 9.8
Nonwhite	2,410	2,450	2,320	2,440	2,186	10.2	— 6.3
Quitman	23,130	23,070	21,660	21.510	21,019	10.0	—18.8
White	8,780	9.200	8,880	7,880	7,715	13.8	—24.2
Nonwhite	14,350	13,870	12,780	13,640	13,304	7.9	—15.3
Rankin	40,850	38,050	36,230	35,460	34,322	19.0	18.8
White	25,180	23,540	21,330	22,590	21,504	17.1	41.4
Nonwhite	15.670	14,510	14,900	12,860	12,818	22.2	— 6.2
Scott	23,550	23,050	22,090	20,890	21,187	11.1	— 2.3
White	15,270	14,640	14,120	13,850	13,050	17.0	6.0
Nonwhite	8,280	8,410	7,970	7,050	8,137	1.8	—13.2
Sharkey	10,720	10,550	11,440	11,340	10,738	......	—16.8
White	3,330	2,980	3,680	3,380	3,247	2.6	—12.4
Nonwhite	7,390	7,570	7,760	7.960	7,491	— 1.3	—18.5

Table 4 Continued: Estimated population and percent of change of Mississippi Counties.

	1964	1963	1962	1961	1960**	Pct. of Change	
						60-64	50-60**
Simpson	21,940	22,240	21,700	20,060	20,454	7.3	— 6.3
White	15,030	15,160	14,010	12,300	13,254	13.2	— 8.9
Nonwhite	6,910	7.080	7,690	7,760	7,200	— 4.0	— 1.0
Smith	15,040	15,860	14,250	14,230	14,303	5.2	—14.6
White	11,690	12.060	10,880	10.980	11,056	5.7	—17.2
Nonwhite	3,350	3,800	3,370	3,250	3,247	3.2	— 4.2
Stone	9,100	6,630	8,680	7,190	7,013	29.8	12.0
White	7,060	4,870	6,840	5,490	5,302	33.2	8.2
Nonwhite	2,040	1,760	1,840	1,700	1,711	19.2	25.3
Sunflower	50,490	48,190	48,730	47.760	45.750	10.4	—18.3
White	16,420	14,820	15,500	16,250	14,730	11.5	—17.6
Nonwhite	34,070	33.370	33,230	31,510	31,020	9.8	—18.7
Tallahatchie	25,800	24,920	24,580	24,390	24,081	7.1	—21.0
White	9,340	8.930	8.770	8.570	8.580	8.9	—22.5
Nonwhite	16,460	15,990	15,810	15,820	15,501	6.2	—20.1
Tate	20,280	21,470	19,060	17,980	18,138	11.8	0.7
White	8,900	9,280	8,190	7,830	7,696	15.6	0.7
Nonwhite	11,380	12,190	10,870	10,150	10,442	9.0	0.7
Tippah	15,860	16,720	16.390	15.220	15.093	5.1	—13.9
White	12,980	13,500	13.730	12,290	12,337	5.2	—12.7
Nonwhite	2,880	3,220	2,660	2,920	2,756	4.5	—18.8
Tishomingo	17,120	16,640	14.620	15,010	13,889	23.3	—10.6
White	16,430	15,930	13,850	14,280	13,210	24.4	—10.4
Nonwhite	690	710	770	730	679	1.6	—15.8
Tunica	17,950	16.960	17.230	16,920	16,826	6.7	—22.3
White	5,040	3,520	3,640	4,080	3.505	43.8	—11.1
Nonwhite	12,910	13.440	13,590	12,840	13,321	— 3.1	—24.8
Union	18,950	20,800	18,830	18,940	18,040	----	— 6.7
White	15,610	17,510	15.850	15.100	15.592	.	— 6.2
Nonwhite	3,340	3,290	2.980	2.940	3,312	0.8	— 8.9
Walthall	13,630	13.450	12.780	13,390	13.512	0.9	—13.2
White	7,150	7.420	7.020	7,370	7.412	— 3.5	—11.7
Nonwhite	6,480	6.030	5.760	6.020	6.100	6.2	—14.9
Warren	43,340	44,160	43,570	41,900	42,406	2.2	6.5
White	23,460	24,440	22.980	22,270	22,447	4.5	15.0
Nonwhite	19,880	19,720	20,590	19,630	19,759	0.6	— 1.7
Washington	78,950	77,180	76,480	78,660	78,638	0.4	11.5
White	35,650	33,710	35,120	33,820	35,239	1.1	50.4
Nonwhite	43,300	43,470	41.360	44,830	43,399	-----	— 7.8
Wayne	15,500	16,180	15.820	16,220	16,258	— 4.7	— 4.4
White	10,600	9.950	10.140	10,680	10,449	1.4	— 3.2
Nonwhite	4,900	6,230	5,680	5,530	5,809	—15.7	— 6.6
Webster	11,170	10,390	10,460	11,180	10,580	5.6	— 8.8
White	8,090	7,540	7,450	7.980	7,938	1.9	—11.0
Nonwhite	3,080	2,850	3,010	3,200	2,642	16.6	— 1.9
Wilkinson	12,460	12.920	12,080	13,160	13,235	— 5.9	— 6.2
White	3,710	3.990	2.990	3,660	3,807	— 2.4	—12.6
Nonwhite	8,750	8,930	9.090	9,500	9,428	— 7.2	— 3.4
Winston	20,580	19,560	19,980	18,310	19,246	6.9	—13.4
White	10,660	10,680	12,080	10,140	10,853	— 1.8	—16.1
Nonwhite	9,920	8,880	7,900	8,170	8,393	18.2	— 9.7
Yallobusha	13,310	12,730	12,400	12,260	12,502	6.5	—17.7
White	7,760	7,080	6,960	6,750	6,962	11.5	—18.4
Nonwhite	5,550	5,650	5,440	5,510	5,540	----	—16.8
Yazoo	32,840	33,480	33,990	30,470	31,653	3.8	—11.4
White	12,840	13.780	13,290	12,320	12,862	..	— 5.6
Nonwhite	20,000	19,700	20,700	18,150	18,791	6.4	—14.9

**Bureau of the Census enumeration.

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Seasonal Host Activity Of The Bollworm And Tobacco Budworm During 1963 In Northeast Mississippi

By J. WENDELL SNOW
and J. R. BRAZZEL

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Seasonal Host Activity of the Bollworm and Tobacco Budworm During 1963 in Northeast Mississippi

J. WENDELL SNOW and J. R. BRAZZEL

INTRODUCTION

The genus *Heliothis* includes two well known species, *Heliothis zea* (Boddie), the bollworm and *Heliothis virescens* (F.), the tobacco budworm. These two species present an economic problem on a world wide scale. In the United States crops such as corn, cotton, tobacco, tomato, alfalfa soybeans, sorghum and many garden vegetables are attacked by one or both species. Many ornamentals including roses, chrysanthemum and snapdragons are also attacked, as well as a whole series of wild plants.

Both species in their southerly distribution are active from March or April until frost, a period which extends beyond the growing season of any single host plant species. Thus a continuous series of host plants are required to extend these species over their active period. Research in Northeast Mississippi was conducted during 1963 to determine the plant species involved in this succession as well as to determine their relative importance as hosts. Special emphasis was placed on occurrence on cotton.

COMMON NAMES

Heliothis zea is known under the common names of corn earworm, bollworm, or tomato fruitworm. All are approved by the Entomological Society of America. For the purposes of this publication *H. zea* will be called the bollworm.

Heliothis virescens, a congeneric species, bears the approved common name of tobacco budworm and will be referred to throughout this bulletin as such or more simply as the budworm.

REVIEW OF LITERATURE

Both *Heliothis* species have been reported as rather general feeders, having a wide variety of cultivated and wild host plants. In general the bollworm has been considered the more dependent on cultivated crops, turning to wild plants in periods when cultivated hosts were not available. On the other hand, the tobacco budworm has been generally considered as relying greatly on wild host species.

When the *Heliothis* complex is viewed from region to region the host relationships of these two species vary greatly. Wolcott (1933) reported that Cuba was the only West Indies Island where tobacco budworms occurred as a pest in tobacco although it was also present on other tobacco producing islands. In Jamaica, he reported bollworms as the typical tobacco pest which in other areas attacks tobacco only very early and again in late season. The bollworm is never found on cotton in Peru but is abundant on corn (Hambleton, 1944, Willie, 1951). In Peru, tobacco budworms are a major cotton pest and, in addition, attack corn. This species does not attack corn in the United States. Brazzel et al. (1953) suggested that these differences in food habits can be explained by regional differences in the availability of wild and cultivated host plants, or can possibly be attributed to the presence of biological races.

Quaintance and Brues (1905) conducting one of the earlier and most extensive studies of the bollworm reported this species as occurring on 72 different species of plants which are included within 21 plant families. In this country bollworms have been collected from plants belonging to 9 families and the tobacco budworm has been recorded as occurring on plants representing 12 families (Chamberlin and Tenhet, 1926; Barber, 1937, Brazzel et al., 1953).

The most thorough previous host plant study of these species was conducted by Barber (1937) in eastern Georgia. He noted corn as the primary host for the bollworm but observed that both flax and tobacco were important prior to corn silking. Of the wild hosts, he reported toadflax as the first plant species attacked and this plant was cited as a very important host in that it provided food for the earliest occurring larvae. A species of "beggar ticks" *Desmodium (Meibomia) purpurea* was reported as the principle food plant beginning in August.

He found toadflax, as with the bollworm, served as the first important food source for budworms. From this host the budworm was reported as moving to *Rhexia alifanus* (Deergrass) on which two generations developed during June and July. He postulated that this species served to tide the budworm over from its common spring food, toadflax, until *Desmodium (Meibomia) purpurea*, its principle fall host, was available.

Brazzel et al. (1953) working in Louisiana and Arkansas collected larvae from 25 plant species. The bollworm was the only species reported on corn, grain sorghum, lima beans, cowpeas, snap beans, chrysanthemum, *Hibiscus rose-sinensis*, vetch, crotalaria, Korean lespedeza and bur clover. This species was dominant on tomato, soybean, alfalfa, white clover, rose, *Sida spinosa* and lupine. They reported the budworm as predominant on tobacco and *Abutilon theophrasti* while this was the only species recorded from snapdragon. Infestations were almost equal on crimson clover and *Jacquemontia tamnifolia*. Both species were recorded in large number from cotton. The tobacco budworm was the predominant species during June and July while the bollworm was predominant after August 1.

In the most recent study, Feunzig (1963) in eastern North Carolina found 10 species of wild plants serving as hosts. As previously reported by Barber (1934), toadflax was found to serve as an excellent early season host for both species. The bollworm was collected from this host continuously from mid-May until mid-June while the budworm was found from early May until the first week in June. During this four year study he found the earlier appearance of the budworm to be consistent. Several species of deergrass, *Rhexia mariana*, *R. mashii* and *R. alifanus* were found to be important mid-season hosts for the budworm. A species of *Desmodium* was reported as a host for both species but was of little importance in this area of North Carolina.

The bollworm has been recognized as a pest of cotton since 1820 (Quaintance and Brues, 1905). The first record of the budworm as a pest was made by Wilson in 1923 in the Virgin Isles. However, this insect was not reported as a cotton pest in the United States until Folsom (1936) in 1934 found large populations feeding on squares and bolls in Louisiana. He suggested that this species had undoubtedly been overlooked on cotton and that much of the damage attributed to bollworms was the result of this species. The seasonal relationship of these two species in cotton was greatly clarified by Brazzel and Newton in 1963. They found in Texas that the tobacco budworm during early season, until mid-June, was the predominant species giving way in July to bollworms, which represented over 90 percent of the total population. Following this period in August and September the budworm was again reported as the dominant species representing approximately 60 percent of the population.

Snow (1964) during the same year, in Georgia, recorded essentially the same results. Tobacco budworms were predominant until the latter part of July. Following this period, large populations of bollworms were recorded but, unlike conditions in Texas, this species remained predominant throughout the remainder of the season. Young and Brazzel (1963) working in Mississippi, found essentially the same situation occurring in that state.

LARVAL COLLECTION METHODS

From March until October, 1963, collections of *Heliothis* larvae were made on cultivated and wild plants in the vicinity of Starkville, Mississippi. Efforts were made to collect from all previously cited hosts occurring in the area as well as other cultivated and wild plants with populations large enough to support either species. Special attention was given to plants belonging in families containing species which had been reported as hosts.

Most of the collections were made in a three county area including Oktibbeha, Lowndes and Clay counties. Collections were made on a weekly basis when possible but due to the large number of plant species involved, counts were often delayed for several days.

The method of collection was determined largely by the nature of the vegetation. In cases of pure stands and where injury to cultivated crops would not result, sweeping with a standard 15-inch insect net was employed. This method could not be used for larvae feeding within fruiting structures. In these cases whole plant or partial plant examinations were employed as the sampling method. With both methods, samples were collected in a random manner from a series of locations so that data would represent average occurrence within the area.

The total number of sweeps or whole plants examined weekly varied greatly, depending on such factors as host availability, infestation and time available for sampling. In the case of sweeping, efforts were made to collect only from uniform, pure stands and sweeps were kept as uniform as possible so that valid population density comparisons within a single species could be made. However, the reader should be warned that density comparisons among the various hosts should be made with extreme caution because of the several collection methods as well as factors such as plant density and nature of the vegetation. An example to illustrate this point may be made by considering sweep comparisons between a loosely branched species such as *Desmodium*, which has a large *Heliothis* feeding area, as compared with sweeps from black medic, which occurs in very thick stands and has a much smaller feeding area. While no sweeping system would collect all larvae within a sampled area, the efficiency in the first case would be much lower than in the case of black medic. For this reason, in comparisons between hosts, more emphasis should be placed on the rise and fall of populations rather than actual larval numbers.

After collection larvae were transported to the laboratory and identified to species by the presence or absence of the mandibular process and microspines on the setigerous tubercles which first appear in the third instar (Brazzel et al. 1953). Larvae too small for identification were reared on artificial diet until they attained the third instar.

Data regarding all principle hosts with a few exceptions will be presented in tabular form as the total number of observations and larvae collected along with a computed value for occurrence per 100 sweeps or whole plants, depending on the particular case. In the case of tobacco, results will be presented on a basis of 50 whole plants because of large larval numbers and on tomatoes in the same fashion since only 50 plants were examined during each weekly period. Occurrence on peanuts, *Desmodium rigidum* and *Haplopappus divaricatus* will be plotted graphically in that only 100 sweeps were taken during each weekly period.

POSITIVE HOST COLLECTIONS

Larvae were collected from a total of 32 species of plants representing 9 plant families.

A list of the plants utilized by bollworms is presented in Table 1. A total of 17 species of cultivated and 11 species of wild plants were recorded as supporting populations. Tobacco budworm larvae during the same period were collected from 8 species of cultivated and 11 species of wild plants (Table 2).

The degree of larval infestation varied greatly between the hosts, ranging from the collection of a single larva to continuous high infestations over an extended period. Host plants of sufficient importance utilized during this season will be discussed under separate headings.

A single bollworm larva was collected from bur clover and two larvae each from white clover, string beans and crotalaria. Three specimens were collected from eggplant and hop clover, while four were collected from Johnson grass and sorghum. Two tobacco budworm larvae were collected from *Hibiscus moscheutos* and three from sweet clover. Infestations were so light on these hosts that no further mention of them will be made.

Crimson Clover: Recently due to policy of the Mississippi Highway Department, vast acreage of this plant is available along roadsides early in the season for *Heliothis* development. In Mississippi, crimson clover blooms in April and May, and at this time of the year is extremely conspicuous in areas where it is common.

Larvae were not observed on this plant

Table 1. Cultivated and wild plants serving as hosts for bollworm larvae in Mississippi.

Common Name	Scientific Name
CULTIVATED PLANTS	
Alfalfa	**Medicago sativa** L.
Corn	**Zea mays** L.
Cotton	**Gossypium hirsutum** L.
Crimson Clover	**Trifolium incarnatum** L.
Crotalaria	**Crotalaria spp.**
Egg Plant	**Solanum melongena** L.
Lespedeza	**Lespedeza sericea** (Thumb.) Benth.
Okra	**Hibiscus esculentus** L.
Peanut	**Arachis hypogaea** L.
Sesame	**Sesamum indicum** L.
String Beans	**Phaseolus vulgaris** L.
Sorghum	**Sorghum vulgare** Pers.
Soybeans	**Glycine max** L.
Spider Flower	**Cleome spinosa** Jacq.
Tobacco	**Nicotiana tabacum** L.
Tomato	**Solanum esculentum** Mill
White Clover	**Trifolium repens** L.
WILD PLANTS	
Beggar's Lice	**Desmodium rigidum** (Ell.) DC.
Black Medic	**Medicago lupulina** L.
Buffalo Bur	**Solanum rostratum** Dunal
Bur Clover	**Medicago hispida** Gaertn.
Cocklebur	**Xanthium pensylvanicum** Wallr.
Hop Clover	**Trifolium procumbens** L.
Horse Nettle	**Solanum carolinense** (L.) Pers
Johnson Grass	**Sorghum halepense** (L.) Pers.
Perennial Pea	**Lathyrus latifolius** L.
Persian Clover	**Trifolium resupinatum** L.
Toadflax	**Linaria canadensis** (L.) Dumont

Table 2. Cultivated and wild plants serving as hosts for tobacco budworm larvae in Mississippi.

Common Name	Scientific Name
	CULTIVATED PLANTS
Alfalfa	**Medicago sativa** L.
Cotton	**Gossypium hirsutum** L.
Crimson Clover	**Trifolium incarnatum** L.
Lespedeza	**Lespedeza sericea** (Thumb.) Benth.
Okra	**Hibiscus esculentus** L.
Sesame	**Sesamum indicum** L.
Spider Flower	**Cleome spinosa** Jacq.
Tobacco	**Nicotiana tabacum** L.
	WILD PLANTS
Beggar's Lice	**Desmodium rigidum** (Ell.) DC.
Black Medic	**Medicago lupulina** L.
Buffalo Bur	**Solanum rostratum** Dunal
Cocklebur	**Xanthium pensylvanicum** Wallr.
Deergrass	**Rhexia** spp.
Haplopappus	**Haplopappus divaricatus** (Nutt.) Gray
Swamp-Rose	**Hibiscus moscheutos** L.
Horse Nettle	**Solanum carolinense** L.
Persian Clover	**Trifolium resupinatum** L.
Sweet Clover	**Melilotus alba** Desr.
Toadflax	**Linaria canadensis** (L.) Dumont

Table 3. Total number of sweeps and Heliothis larvae collected weekly from crimson clover in 1963.

Week	Number Sweeps	Total No. Collected		Average No. per 100 Sweeps	
		Bollworm	Budworm	Bollworm	Budworm
March 25-31	140	0	0	0.0	0.0
Apr. 1-7	140	0	0	0.0	0.0
Apr. 8-14	120	0	0	0.0	0.0
Apr. 15-21	160	13	0	8.1	0.0
Apr. 22-28	585	71	0	12.1	0.0
Apr. 29-May 5	250	17	4	6.8	1.6
May 6-12	105	73	1	66.4	0.9
May 13-19	100	104	16	104.0	16.0
May 20-26	100	60	4	60.0	4.0

until April 15-21 at which time clover was in early bloom. As shown in Table 3, the bollworm was the predominant species on this plant throughout the collection period. From the initial bollworm population of 8.1 larvae per 100 sweeps observed April 15-21, the infestation climbed for the next several weeks reaching a peak of 104.0 larvae per 100 sweeps during May 13-19.

At this time crimson clover was in late bloom stage. The following week the infestation had decreased to 60 larvae per 100 sweeps. Beyond this period, crimson clover was completely dead and unsuitable for larval development.

Tobacco budworm larvae were observed 2 weeks later on this host than the bollworm and infestations were always smaller. The first larvae were found during April 29-May 5 (average 1.6 per hundred sweeps) and the maximum population was reached during May 13-19 when an average of 16 larvae per 100 sweeps were counted.

The large bollworm population observed in the early spring demonstrates the importance of this crop as an early host in 1963. This crop facilitated the building up of large bollworm populations which served as a source of moths for later oviposition on economic crops. Even though budworm populations were low on this host it must be remembered that crimson clover's abundance makes this an equally important early spring host for this species.

Persian Clover: This legume is native to southeastern Europe and is naturalized, to a limited extent, in the southern United States. It is considered a minor forage crop (Isley, 1950), but has high feed value and may become more valuable in the future as an early spring pasture crop. In Mississippi this plant occurs to a small extent along roadways, and wet bottom land. The blooming period is in April and May.

Both species of *Heliothis* were recorded in the initial sweepings on this plant during April 29-May 5. At this time the clover was in full bloom. As shown in Table 4, an average of 5.2 larvae per 100 sweeps was recorded for both species on this date. Several of these larvae were in the advanced instars, indicating they were present at least a week prior to this time. The tobacco budworm seemed to prefer this host, reaching a population peak of 40 larvae per 100 sweeps during May 6-12. Bollworm populations had dropped to an average of 4 larvae for this weekly period. The following week Persian clover was in the final stages of development and both species were recorded in lower frequency. Persian clover had completely died by May 20-26 and no larvae were collected.

It is obvious from these results that Persian clover is an adequate host, capable of supporting large populations of both species of *Heliothis*. Its importance in the area under discussion is limited because of sparse occurrence but it is evident that this crop is a potentially important early spring host in areas where it is common.

Lespedeza: This legume is found throughout the South, commonly serving as a hay and forage crop. This plant has also escaped from cultivation and is common along roadways and open land. It commonly blooms during May and June.

Larvae of both species were first swept from this plant feeding on foliage during May 6-12. As shown in Table 5, infestations continued over a period of about one month. Although infestations were low, all lespedeza swept in the area had populations of both species. The peak occurrence for bollworms was during May 13-19, while peak abundance of budworms occurred 2 weeks later (May 27-June 2). After June 3-9, no larvae were found until September 2 when two budworm larvae were collected.

Table 4. Total number of sweeps and Heliothis larvae collected weekly from Persian clover in 1963.

Week	Number Sweeps	Total No. Collected		Average No. per 100 Sweeps	
		Bollworm	Budworm	Bollworm	Budworm
Apr. 29-May 5	210	11	11	5.2	5.2
May 6-12	200	8	80	4.0	40.0
May 13-19	100	1	4	1.0	4.0
May 20-26	100	0	0	0.0	0.0

Table 5. Total number of sweeps and Heliothis larvae collected weekly from lespedeza sericea in 1963.

Week	Number Sweeps	Total No. Collected		Average No. per 100 Sweeps	
		Bollworm	Budworm	Bollworm	Budworm
Apr. 29-May 5	75	0	0	0.0	0.0
May 6-12	300	3	3	1.0	1.0
May 13-19	350	8	5	2.3	1.4
May 20-26	300	3	7	1.0	2.3
May 27-June 2	240	1	10	0.4	4.2
June 3-9	700	0	8	0.0	1.1
June 10-16	100	0	0	0.0	0.0
		Zero during this period.			
Sept. 2-8	100	0	2	0.0	2.0

Table 6. Total number of whole plants examined and Heliothis larvae collected weekly from tobacco in 1963.

Week	Number Plants	Total No. Collected		Average No. per 50 Plants	
		Bollworm	Budworm	Bollworm	Budworm
Apr. 29-May 5	88	0	6	0.0	3.4
May 6-12	88	0	2	0.0	1.1
May 13-19	88	0	4	0.0	2.3
May 20-26	88	0	0	0.0	0.0
May 27-June 2	50	0	4	0.0	4.0
June 3-9	76	5	189	3.3	124.3
June 10-16	60	9	105	7.5	87.5
June 17-23	60	4	56	3.3	46.7
June 24-30	50	0	90	0.0	90.0
July 1-7	50	0	99	0.0	99.0
July 8-14	60	0	144	0.0	120.0
July 15-21	60	0	138	0.0	115.0
July 22-28	50	0	156	0.0	156.0
July 29-Aug. 4	60	3	111	2.5	92.5
Aug. 5-11	60	0	78	0.0	65.0
Aug. 12-18	50	10	50	10.0	50.0
Aug. 19-25	60	4	36	3.3	30.0
Aug. 26-Sept. 1	50	2	39	2.0	39.0

Lespedeza apparently served as a host for one generation of both species early in the season when other hosts were not available. The absence of larvae during most of June and all of July and August even though this plant was available in a succulent condition indicates that it was not a preferred host but served adequately when other plants were not available.

Corn: In Mississippi corn is commercially planted from the middle of March to the last week in May. Bollworms were first observed in May feeding in the tassels. From mid-June until late August silking corn was available in a condition suitable for oviposition and during these months almost the entire bollworm population was found on this host. No plant seemed capable of competing with corn in attractiveness. All corn in the area had ear infestations in excess of 90 percent. Multi-larval infestations were common but confined primarily to the earlier instars because of the cannibalistic nature of the older larvae. Data regarding occurrence on this host are not presented because infestations were at such high levels that data would reflect levels of cannibalism, disease etc. rather than actual fluctations in the seasonal population.

As will be discussed later, absence of this species from other hosts during this period serves as an indicator of the importance of corn as a host.

Tobacco: This is a cultivated crop of several southern states but is not cultivated commercially in Mississippi. Small plantings were grown during 1963 for research purposes. Larval counts were made by individual examination of the whole plants. As shown in Table 6, with the exception of a single collection period, constant populations of tobacco budworms were observed during the entire growing season. In the weeks following May 27-June 2 populations of this species were extremely high, at times averaging over 3 larvae per single plant, (Table 6). During this period plant terminals and upper leaves were covered with eggs. As shown in Table 6, two peaks of abundance for this species may be observed. However, it appeared that variations in weekly populations were more greatly influenced by parasitism than by actual changes in the population. Parasitism was primarily by a species of Braconidae, *Cardiochiles nigricepes* Vier., which appeared to be highly effective in reducing the population in late stages of larval development.

Bollworm larvae were collected during two different periods but populations were always small. Of special significance is that the earlier bollworm infestations preceded corn silking while larvae were not observed again until early August, a time when corn was not available for oviposition.

Spider-Flower: This ornamental, a previously unreported host for the *Heliothis* complex, belongs in the family Capparidaceae, and is a common shrub found in and around yards. Gray's manual (Fernald, 1950) lists the distribution of this plant as Florida to Texas, and north to Massachusetts, Indiana and Ohio. This plant is common in Mississippi, being prized for its beautiful rose or white colored petals and long blooming period, which lasts from June until frost.

Observations were begun on this plant during June 24-30 at which time it was blooming well. Counts were based on the number of larvae per flower head including that area beneath the bloom which contained developing pods. Larvae were never observed below this point, confining their feeding within the flower heads and seed pods.

Table 7 demonstrates the acceptance of spider-flower as a host by the tobacco budworm. A continuous population was observed from June 24-30 until the last count was made during October 14-20. Four definite population peaks may be observed spaced at exact 5 week intervals. These may be interpreted as distinct generations which indicate that spider-flower is a preferred host. Several advanced instar larvae were found among the 42 specimens of tobacco budworm collected in the initial observation which indicates that larvae were present prior to the first collection period.

Bollworms were not observed on spider-flower until August 19-25. Populations of this species were continuous but low for the remainder of the season, never averaging over 5.3 larvae per 100 flower heads. As in the previous case, infestations did not occur until corn was lost as a host.

Okra: This cultivated crop is an introduction from Africa and is commonly found in small home gardens. It begins blooming in late May or early June and provides an excellent host for both species of *Heliothis* until late October.

Whole plants examinations were begun on this plant in early May when it was up to stand. The weekly seasonal occurrence data for both *Heliothis* species are shown in Table 8. No larvae were observed until after blooming had begun during June 3-9 at which time a single bollworm specimen

Total 7. Total number of flower heads examined and Heliothis larvae collected weekly from spider-flower in 1963.

Week	Number Heads	Total No. Collected		Average No. per 100 Heads	
		Bollworm	Budworm	Bollworm	Budworm
June 24-30	125	0	42	0.0	33.6
July 1-7	115	0	10	0.0	8.7
July 8-14	170	0	4	0.0	2.4
July 15-21	100	0	1	0.0	1.0
July 22-28	100	0	2	0.0	2.0
July 29-Aug. 4	150	0	16	0.0	10.7
Aug. 5-11	100	0	7	0.0	7.0
Aug. 12-18	100	0	8	0.0	8.0
Aug. 19-25	100	1	7	1.0	7.0
Aug. 26-Sept. 1	300	2	29	0.7	9.7
Sept. 2-8	125	3	15	2.4	12.0
Sept. 9-15	75	3	5	4.0	6.7
Sept. 16-22	75	4	4	5.3	5.3
Sept. 23-29	300	15	35	5.0	11.7
Sept. 30-Oct. 6	100	4	17	4.0	17.0
Oct. 7-13	100	3	19	3.0	19.0
Oct. 14-20	100	1	15	1.0	15.0

Table 8. Total number of whole plants examined and Heliothis larvae collected weekly from okra in 1963.

Week	Number Plants	Total No. Collected		Average No. per 100 Plants	
		Bollworm	Budworm	Bollworm	Budworm
June 3-9	60	1	0	1.7	0.0
June 10-16	100	3	0	3.0	0.0
June 17-23	25	1	0	4.0	0.0
June 24-30	100	5	0	5.0	0.0
July 1-7	50	1	0	2.0	0.0
July 8-14	75	0	0	0.0	0.0
July 15-21	50	1	0	0.5	0.0
July 22-28	200	3	4	1.5	2.0
July 29-Aug. 4	100	3	20	3.0	20.0
Aug. 5-11	100	1	15	1.0	15.0
Aug. 12-18	250	2	25	0.8	10.0
Aug. 19-25	100	0	8	0.0	8.0
Aug. 26-Sept. 1	100	2	22	2.0	22.0
Sept. 2-8	100	3	18	3.0	18.0
Sept. 9-15	100	6	9	6.0	9.0
Sept. 16-22	200	11	14	5.5	7.0
Sept. 23-29	225	6	9	2.7	4.0
Sept. 30-Oct. 6	100	1	9	1.0	9.0
Oct. 7-13	100	3	13	3.0	13.0
Oct. 14-20	75	3	17	4.0	22.7
Oct. 21-27	100	4	17	4.0	17.0

Table 9. Total number of sweeps and Heliothis larvae collected weekly from alfalfa in 1963.

Week	Number Plants	Total No. Collected		Average No. per 100 Sweeps	
		Bollworm	Budworm	Bollworm	Budworm
May 20-26	250	13	1	5.2	0.4
May 27-June 2	175	4	1	2.3	0.6
June 3-9	300	2	1	0.7	0.3
June 10-16	150	8	1	5.3	0.7
June 17-23	100	0	0	0.0	0.0
June 24-30	50	0	0	0.0	0.0
		All alfalfa cut during this period.			
July 15-21	100	0	0	0.0	0.0
July 22-28	100	0	0	0.0	0.0
		All alfalfa cut during this period.			
Aug. 12-18	100	6	0	6.0	0.0
Aug. 19-25	200	16	0	8.0	0.0
Aug. 26-Sept. 1	100	35	1	35.0	1.0
Sept. 2-8	100	23	0	23.0	0.0
Sept. 9-15	100	15	0	15.0	0.0
Sept. 16-22	100	19	0	19.0	0.0
Sept. 23-29	100	35	0	35.0	0.0
Sept. 30-Oct. 6	100	20	0	20.0	0.0
Oct. 7-13	100	9	0	9.0	0.0
Oct. 14-20	100	1	0	1.0	0.0

was collected. Bollworm populations, although fairly constant, were low throughout the season. However, in viewing Table 8, 4 distinct generations may be observed peaking on the weeks beginning June 24, July 29, September 9 and October 14.

The tobacco budworm was not collected until the week July 22-28. Infestations by this species were much higher than for the bollworm. Three distinct generations reaching densities of 20 or more larvae per 100 whole plants were observed during the weeks beginning July 29, August 26 and October 14.

This host appears to be preferred by both species of *Heliothis*. Although infestations were rather continuous throughout the growing period, this host probably is more important in building up overwintering populations than actually sustaining populations during early and mid-season because of the practice of removing pods for table consumption. Plantings are usually abandoned in late season, however, which provides an opportunity for undisturbed generations.

Alfalfa: This legume is common in the area discussed both in cultivation and as an escape along roadsides and in waste areas. It blooms in early summer unless continually cut for hay or silage.

Sweeping was begun early in the spring and continued throughout the season. Weekly occurrence data are shown in Table 9. Budworm populations were insignificant on this plant. In all 5 larvae were collected, 2 in late May, 2 in early June and a single specimen during the week of August 26-September 1.

Bollworm larvae were not recorded until May 20-26 when an average of 5.2 larvae per 100 sweeps was recorded (Table 9). Populations were present but low for the following 3 week period. Larvae were not found again until August 12-18 when an average of 6.0 larvae per 100 sweeps was recorded. The population climbed rapidly for the next 2 weeks, reaching an average of 35 larvae per 100 sweeps during August 26-Sept. 1. Populations declined for the next 2 weeks, reaching a low of 15.0. From this point the population again reached an average of 35.0 larvae per 100 sweeps during September 23-29. From this point the population dropped, reaching a low of 1.0 larvae per 100 sweeps during the last positive collection period of Oct. 14-20.

The effect of cutting alfalfa for hay places some doubt on the value of this plant as a host for bollworms in northeast Mississippi. In a well managed field the first cutting is normally made toward the middle of April with cuttings following approximately every 28 days, depending on temperature and moisture (Meredith, W. R., 1964, personal communication). Certainly if the practice is followed great mortality could be expected in early instars. Late season management however, is much more conducive to large populations. Normally in the late fall, alfalfa is allowed to stand longer in the field and is cut just prior to the date of frost. This is done to prevent tender regrowth before frost, but this practice also provides ample time for a large brood of bollworms to enter the soil and pupate.

Cotton: Particular attention was given to Heliothis occurrence on this crop because of the monetary loss suffered by cotton farmers each year from the feed-

Table 10. Total number of whole plants examined and Heliothis larvae collected from cotton in 1963.

	Number	Total No. Collected		Average No. per 100 Plants	
Week	Plants	Bollworm	Budworm	Bollworm	Budworm
May 6-12	300	0	1	0.0	0.3
May 13-19	500	0	0	0.0	0.0
May 20-26	500	0	0	0.0	0.0
May 27-June 2	1000	0	0	0.0	0.0
June 3-9	1038	2	14	0.2	1.4
June 10-16	1100	14	30	1.3	2.7
June 17-23	1006	10	30	1.0	3.0
June 24-30	1595	23	42	1.4	2.6
July 1-7	1676	2	24	0.1	1:4
July 8-14	1305	1	18	0.1	1.4
July 15-21	1231	7	41	0.6	3.3
July 22-28	1024	13	41	1.3	4.0
July 29-Aug. 4	1192	18	28	1.5	2.4
Aug. 5-11	1060	72	30	6.8	2.8
Aug. 12-18	1266	231	27	18.3	2.1
Aug. 19-25	1080	189	6	17.5	0.6
Aug. 26-Sept. 1	1100	54	10	4.9	0.9
Sept. 2-8	700	38	4	5.4	0.6
Sept. 9-15	925	29	4	3.1	0.4
Sept. 16-22	950	21	4	2.2	0.4
Sept. 23-29	500	16	0	3.2	0.0

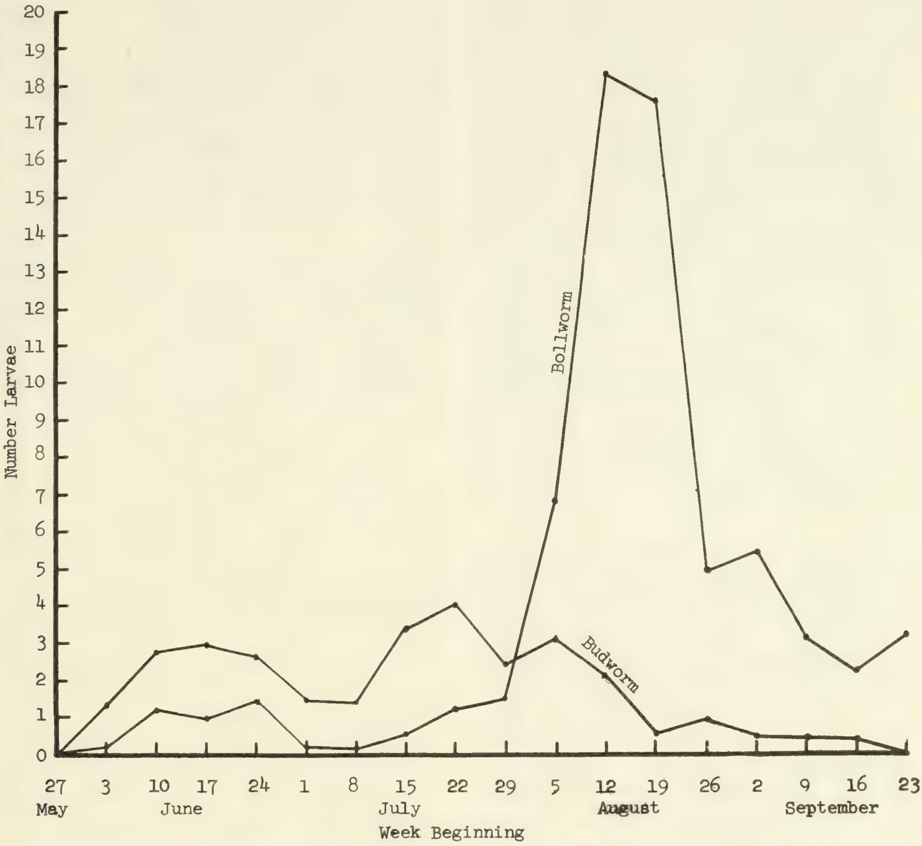

Figure 1. Seasonal abundance of Heliothis larvae on cotton per 100 whole plants in 1963.

ing of both species in squares and bolls.

Collections on this plant were made weekly in 500 acres of cotton scattered throughout Oktibbeha, Lowndes, and Clay counties. Counts were made by individual examination of whole plants. The fields were planted for commercial production and standard practices and procedures popular in this area were used. However, in all cases, no insecticides were used until early August when high infestations of bollworms forced their use.

Observations began when cotton was up to a stand and continued until killing frost. Both species were collected during this period. The total number of whole plants examined and number of larvae collected is shown in Table 10. The seasonal average occurrence of these species based on the number of larvae per 100 whole plants is shown graphically in Figure 1.

A single tobacco budworm larva was collected in May when cotton was in the two leaf stage. Larvae were not observed for the next several weeks until June 3-9 at which time both species were collected. Cotton during this period was just beginning to square. On this date the budworm population averaged 1.4 larvae per 100 whole plants while the bollworm population was only 0.2 larvae per 100 whole plants (Table 10). From this period the tobacco budworm population increased reaching a peak of 3.0 larvae per 100 whole plants during July 17-23. For the next 3 weeks the population declined reaching a low of 1.4 larvae per 100 whole plants. From this point the population climbed for the next several weeks reaching a seasonal high of 4.0 larvae during July 22-28. After this week the population declined for 4 weeks, reaching a low of 0.6 larvae per 100 whole plants. For the remainder of the season populations never reached over 0.9 larvae per 100 whole plants. No tobacco budworm larvae were observed after September 16-22, although counts were continued until frost.

Two definite population peaks may be seen for this species (Figure 1) during the weeks June 17-23 and July 22-28. In both cases, egg counts prior to these low points ranged from 5 to 20 eggs per 100 terminals. In these untreated fields, larval populations remained below economic levels and no real yield loss could be attributed to this species. However, in adjacent cotton fields where applications of insecticides had been made in anticipation of Heliothis infestations, populations reached higher levels and economic damage resulted. This can be attributed to the insecticidal reductions in the predator and parasitic populations which were highly effective in reducing *Heliothis* in the untreated fields.

Bollworms were a much more serious pest in cotton fields in the 3 county area than was the budworm. From the initial level of 0.2 larvae (Table 10) per 100 whole plants observed during June 3-9 infestations remained below an average of 2 larvae per 100 plants until August 5-11 when population levels reached an average of 6.8 larvae per 100 whole plants. A peak of 18.3 larvae per 100 whole plants was reached the following week. This count was based on a total of 1266 whole plants and infestations were uniform throughout the collection area. The use of insecticides was necessary during this period to bring infestations below an economic level. During this period egg counts were extremely high, ranging from 40 to several hundred per 100 whole plants. The eggs were commonly placed on all areas of the plant including bolls, squares and blooms. Eggs from these 3 sites were collected and hatching larvae were placed on media and reared to identification size. In all cases larvae were identified as bollworms. In the field, larvae hatching from these positions were extremely difficult to control with chemicals.

Following this period of high numbers of both eggs and larvae, populations declined for the next several weeks to a low of 2.2 larvae per 100 whole plants during September 16-22. Populations increased slightly to an average of 3.2 larvae the following week. After this period most cotton fields had terminated and harvest had begun but counting was continued in fields of late cotton or slow

Table 11. Total number of sweeps and Heliothis larvae collected weekly from black medic in 1963.

Week	Number Sweeps	Total No. Collected		Average No. per 100 Sweeps	
		Bollworm	Budworm	Bollworm	Budworm
May 6-12	150	3	0	2.0	0.0
		Zero during this period.			
June 10-16	75	2	4	2.7	5.3
June 17-23	100	0	8	0.0	8.0
June 24-30	100	0	3	0.0	3.0
		Plants not available during this period.			
July 15-21	200	0	70	0.0	35.0
July 22-28	325	3	76	0.9	23.4
July 29-Aug. 4	200	1	16	0.5	8.0

maturing fields. Large populations of bollworms were encountered in these fields up to the first killing frost indicating that another population peak occurred. Data for this period are not presented, however, because infestations were spotted and occurrence data by necessity would be biased. However, the point that no budworms were collected during this period should be made.

Black Medic: This legume is established throughout most of the United States and is commonly found in Mississippi as a weed along roadsides and in waste places. It may be seen blooming throughout the summer.

A total of 9 bollworm larvae were swept from this plant during May, June and July of 1963 (Table 11). Populations of this species were always low and during 1963 must be considered a minor host. Tobacco budworms on the other hand, were found in much larger numbers. The first positive collection for this species was June 10-16 when an average of 5.3 larvae per 100 sweeps was collected (Table 11). The following week 8.0 larvae were collected which dropped to an average of 3 larvae per 100 sweeps during June 24-30. Counts were not taken for the next two weeks because available black medic had been cut by highway crews. Populations were again found on July 15-21 when an average of 35 larvae per 100 sweeps was recorded. For the next two weeks smaller populations were recorded but all larvae were in advanced instars indicating that oviposition had occurred during a few days period and the sweeping had recorded the same brood of larvae in different stages of development.

During 1963, two generations of budworms developed on black medic. The first generation in June was rather small with the second in July and August reaching much greater proportions. Larvae were collected from several locations in the area, apparently black medic was rather generally infested. In view of the wide spread abundance of this host, it must be considered an excellent host for continuing the species during mid-season.

Tomato: Observations were begun as soon as tomatoes became established in the fields and were continued until midsummer. During this period a total of 50 whole plants were examined weekly. The total number of larvae collected is shown graphically in Figure 2. Only the bollworm was recorded as attacking this plant. A total of 23 second and third instar larvae was collected during June 3-8. The tomatoes at this time were blooming and a few young fruits were present which, along with foliage, served as the source of food. The following week (June 10-16) 10 fourth and fifth instar larvae were collected. Only 2 larvae were found the following week. No larvae were collected after the month of June and no second or third instar larvae were collected after the initial week. This indicates that oviposition occurred only during a very short period and that this plant served as a host for only one generation of larvae prior to corn silking.

Peanuts: Peanuts are not commercially grown in Mississippi but are commonly found in small plots in rural sections of the state where they are grown for home consumption. This crop is normally planted in April but infestations by the bollworm were not recorded until August 5-11. On this date 20 second and third instar bollworm larvae were recorded in 100 sweeps, (Figure 2). The following week 13 larvae were collected in 100 sweeps and an additional 8 larvae the following week. Peanuts were harvested before additional counts were made.

Although peanuts in Mississippi are available as a host only to a limited extent the timing of infestations makes this an interesting host. No larvae were recorded during the peak vegetative or flowering period of this plant. Infestations occurred only in late stages of development and

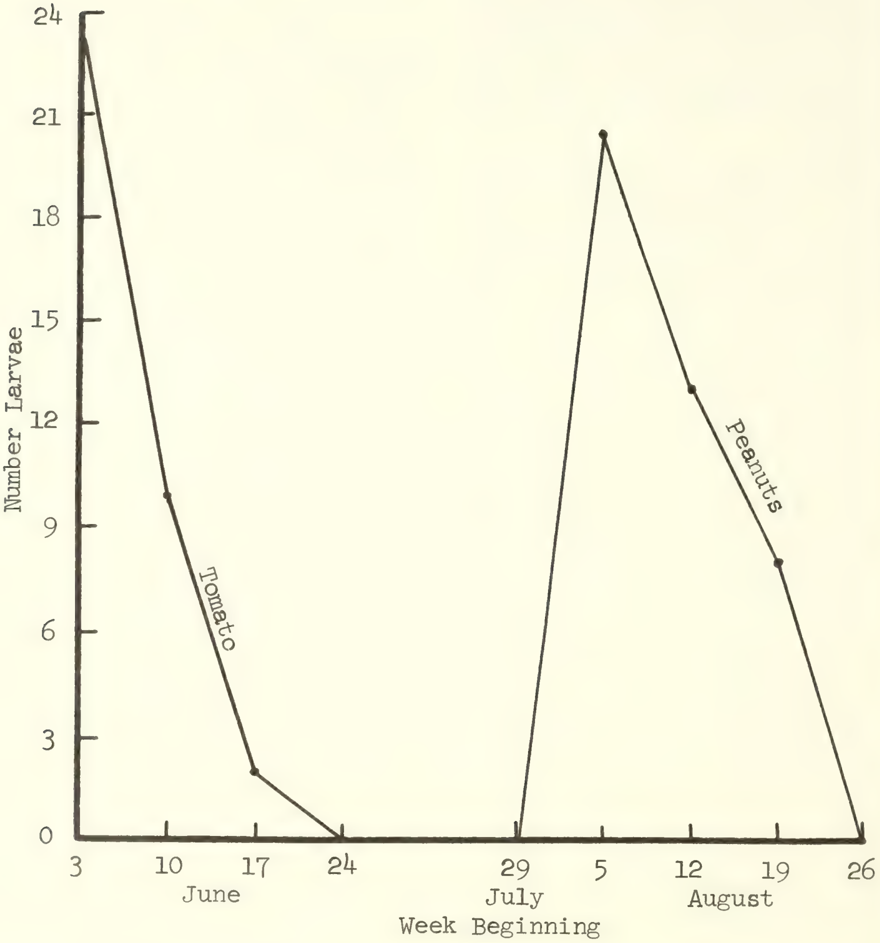

Figure 2. Seasonal abundance of bollworm larvae on tomato per 50 whole plants and per 100 sweeps on peanuts in 1963.

at a time when the plants should have been less, rather than more, attractive. This case provides excellent evidence of the inability of plant species to compete with corn in attractiveness to the bollworm.

Desmodium Rigidum: Members of the genus *Desmodium Desv.*, commonly called tick-trefoil, tick-clover or beggar's ticks are commonly found throughout the world except the western United States, Europe and New Zealand. In this area

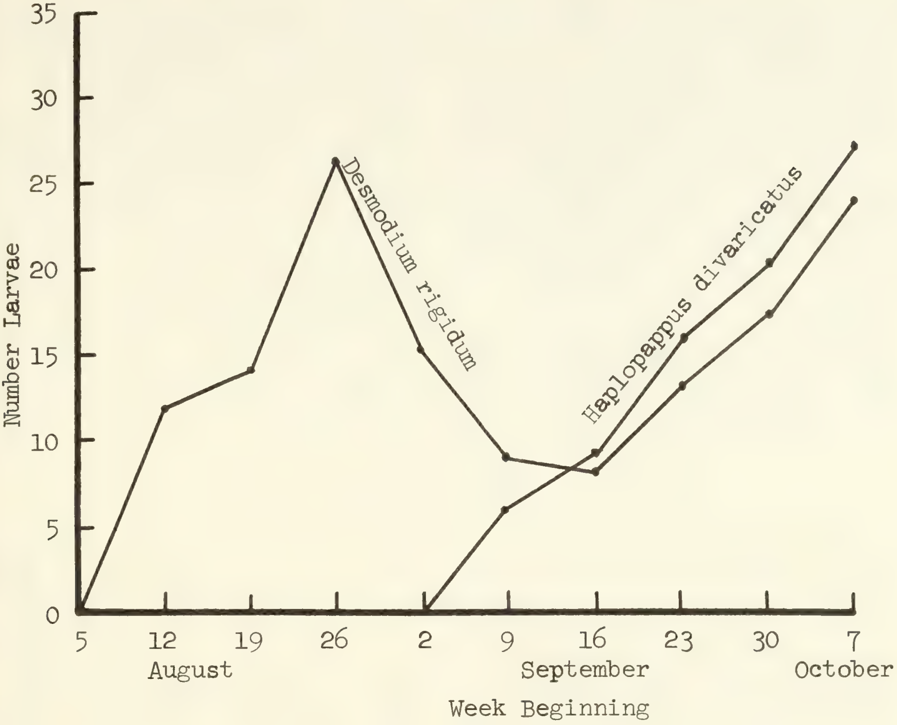

Figure 3. Seasonal abundance of tobacco budworm larvae per 100 sweeps on Desmodium rigidum and Haplopappus divaricatus in 1963.

of Mississippi a number of species occur but only one, *Desmodium rigidum*, was found supporting *Heliothis* populations. According to Grays Manual (Fernald, 1950) this species is found from Massachusetts to south Michigan and Indiana, south to South Carolina, Florida and east Texas. This plant is common in dry sandy or sandy loam soil, often occurring in rather thick stands 3 to 5 feet tall. It begins blooming and maturing seeds in late July and from then on throughout the season it becomes increasingly plentiful reaching its greatest abundance during September. By the first of October most of the seeds are ripe and too hard for larval food.

The tobacco budworm was first collected by sweeping on this plant during the week of August 5-11. From this initial population of 12 larvae in 100 sweeps, a peak of 26 larvae in 100 sweeps was recorded during August 26-September 1 (Figure 3). Populations decreased for the next 3 weeks reaching a low of 8 larvae in 100 sweeps during September 16-22. Populations again rose beyond this period reaching a high of 24 larvae in 100 sweeps during the week Otober 7-13. Most of these larvae were in advanced instars.

Two distinct generations of the tobacco budworm may be noted as utilizing this plant as a source of food. A total of 138 larvae was collected and it becomes apparent that this plant serves as a primary host of great importance in late season. Only 3 bollworm larvae were collected from this plant in August.

Haplopappus Divaricatus: This plant is a loosely branched annual occurring very commonly in lands that have been recently cultivated. Gray's Manual (Fernald, 1950) lists the distribution from Florida to south Texas, north to southeast Virginia, Arkansas and Kansas. The blooming period is in September and October. It is a member of the family Compositae.

The tobacco budworm was first observed September 9-15 feeding on the leaves, flower buds and unripe seed pods. On this date a total of 6 larvae in 100 sweeps was collected (Figure 3). These larvae were all in early stages of development. For the following weeks the population gradually increased reaching a peak of 27 larvae in 100 sweeps on October 7-13. All larvae were in advanced instars and beyond this period no larvae were collected because of host termination. In all a total of 78 tobacco budworms was collected. No bollworms were recorded.

Only one large generation occurred on this host but like *Desmodium*, it serves as an important late food plant and probably has great significance in the overwintering of this species.

OCCASIONAL HOSTS

Larvae of one or both species were collected on a series of plants during 1963 in which infestations were short-termed or low. These plants have been designated as occasional hosts but it should be remembered that the lack of extensive infestations is probably due to the presence of more favorable food plants. In the absence of these plants these occasional hosts would probably play a greater role in the seasonal biology of these species. These hosts with the total number of larvae collected during 1963 are shown in Table 12.

Horse Nettle is abundant from May to August principally on cultivated ground or soil that has been cultivated within the past few years. It also occurs rather commonly in pastures which are not cut regularly. Larvae of both species were observed feeding on the flower buds, tender foliage and unripe fruit.

Positive collections of the budworm were recorded during the last week of May and the first two weeks of June. During this period a total of 9 larvae was collected. A single bollworm was collected on May 22 but no others were recorded again until August 14 when 5 larvae were collected.

Although larvae were not found in large numbers, the abundance of the plant in the area makes this plant serve as a potentially important host.

Buffalo Bur is native to our Western Plains and has become an aggressive weed through most of the northern and eastern states. This plant is in the same genus as

Table 12. Collections of Heliothis larvae from plants serving as occasional hosts during 1963.

Host	Months Collected	Number Larvae Collected	
		Bollworm	Budworm
Buffalo bur	May, June, July	12	12
Cockle bur	May and August	6	1
Deergrass	July and August	0	9
Horse nettle	May, June, August	6	9
Perennial pea	June	13	0
Sesame	June, August, September	7	207
Toadflax	May and June	4	8
Soybeans	May	7	0

horse nettle but is much less abundant in northeast Mississippi. Both *Heliothis* species attacked this plant in equal numbers feeding primarily on leaves and flowers. The bollworm confined its attack to a short period in late May and early June. The tobacco budworm was found only in late June and early July. In both cases a total of 12 larvae was collected.

Cockle Bur is an inhabitant of bottom land, low ground, cultivated and waste places throughout the southeastern United States. It is very common in northeast Mississippi and was found to be infested with a total of 6 bollworms and one tobacco budworm in May and August. The burs, buds and leaves to a lesser extent, were utilized as food.

Five of the bollworms were collected on August 21 within an infested peanut field. In this case oviposition may have occurred on peanuts with larval migration to cockle bur.

Deergrass is an inhabitant of moist lowland soils or along water-filled or moist ditches. Green seed capsules become available between July and August and small populations of tobacco budworms were found feeding on them. This plant has been reported in North Carolina (Feunzig, 1963) and Georgia (Barber, 1934) as a principal food plant of both bollworms and budworms but appeared to be of a secondary nature in Mississippi as a host for budworms.

Toadflax has been reported as the principle spring host for both *Heliothis* species in eastern Georgia (Barber, 1937) and eastern North Carolina (Feunzig, 1963). In northeast Mississippi this plant is fairly common as a weed in recently cultivated fields and waste places. Blooming usually occurs in May and June. Infestations by both species in 1963 were small, a total of 8 tobacco budworms and 4 bollworms larvae being collected in May and June.

Perennial pea has escaped from cultivation and is found along roadsides and waste places in Mississippi. It commonly occurs in association with vetch and has similar blooming habits. A total of 13 bollworm larvae was collected in the first 3 weeks of June. This plant apparently has some importance as a temporary host, serving between crimson clover, the most common spring host, and corn, the primary mid-season host.

Sesame, a cultivated crop of certain parts of Texas, is grown primarily for seed which are sold commercially as bird food. This crop was grown during 1963 in Stoneville, Mississippi, for research purposes. During a trip to that area on June 21, the writer observed that almost every terminal contained a young first instar larvae. Seventy such larvae were collected and brought to State College and reared to identification size. Of these 36 lived to be identified and all were tobacco budworms.

Seeds were planted at this time at State College but the plants did not bloom until late August and early October. During this period sesame was severely attacked by tobacco budworms comparing to infestations on tobacco. During this short period a total of 171 tobacco budworm and 7 bollworm larvae was collected.

Soybeans are widely grown in Mississippi and upon occasions are severely damaged by bollworm larvae. Infestations may occur in early summer and feeding is limited to foliage but the plants are most suitable as hosts in August and September when pods are available as larval food.

Damage to soybeans in northeast Mississippi was almost non-existent during 1963. A total of 7 bollworm larvae was collected during the month of May. No late damage occurred, primarily because soybeans had terminated by early August before severe damage usually occurs.

RELATIONSHIP OF HOST TO BOLLWORM

In order to demonstrate the host sequence of the bollworm as it relates to time during 1963, its occurrence on the various hosts is shown in silhouette form in Figure 4. The various silhouette sizes are based on the average occurrence units used under the separate discussion of each host. For this reason the reader should recall the limitation and example given in the methods section regarding comparisons among the various hosts. Occurrence on many of the plants classed as occasional hosts are also shown but in these cases the plot has relationship only to time of infestation and not to any sample unit.

Based on larval records, bollworm moths first emerged from overwintering pupae during late March or early April. In the area under discussion crimson clover and to a lesser extent Persian clover and lespedeza provided the principle early hosts for this species. Toadflax, reported by Barber (1937) and Feunzig (1963) as an important early spring host in other areas was found with only light infestations even though fairly abundant. Small populations of first generation bollworms were also recorded on black medic, soybeans, and alfalfa.

The extremely high infestations recorded on crimson clover demonstrates the preference exhibited for this species by the bollworm. In the ecological situation of 1963 crimson clover may be considered as the principle source of second generation moths. Vetch, an often reported spring host, was never found infested.

The second generation in early and mid-June was passed primarily on whorl stage corn, tomato, tobacco, alfalfa, okra and cotton. Tomato was severely attacked with infestations up to 23 larvae per 50 whole plants. Buffalo bur, horse nettle and perennial pea were occasionally infested. The lack of populations on these hosts after mid-June clearly demonstrates the preference exhibited by bollworms for corn which begins to silk at this time. This is particularly evident when considering that all the hosts were in the early stage of growth and should have become more, rather than less, attractive for oviposition. Two generations were passed on corn which silks continuously from mid-June to late July depending on the planting date. Data for corn occurrence is not shown for reasons already stated but the absence or lowness of populations on other hosts indicates activity on this crop.

From early August, with the loss of corn as a suitable host, the fifth generation turned to a series of hosts. In this case plants in late stages of development, actually less suitable from the standpoint of succulence and fruiting structures than they had been previously, were found infested. Peanuts, well beyond their active growing period, were found to support relatively large populations. Populations were again recorded on alfalfa and tobacco which had been negative during the entire period of corn silking. Infestations were particularly high on alfalfa reaching an average of 35 larvae per 100 sweeps. Smaller infestations were noted on okra and spider-flower. This generation was extremely important from an economic standpoint on cotton. As already discussed, applications of insecticides became necessary and in cases of poor control losses were suffered at a time when cotton could not replace destroyed bolls. It is obvious that corn served as the primary host in building up large populations of bollworm moths which utilized cotton for oviposition.

The final generation in late September and early October was passed essentially on the same hosts. Cotton in most fields had terminated and larvae were absent in these cases but were present in the few fields remaining in a fruiting condition. Other peaks were noted on alfalfa, spider flower and okra.

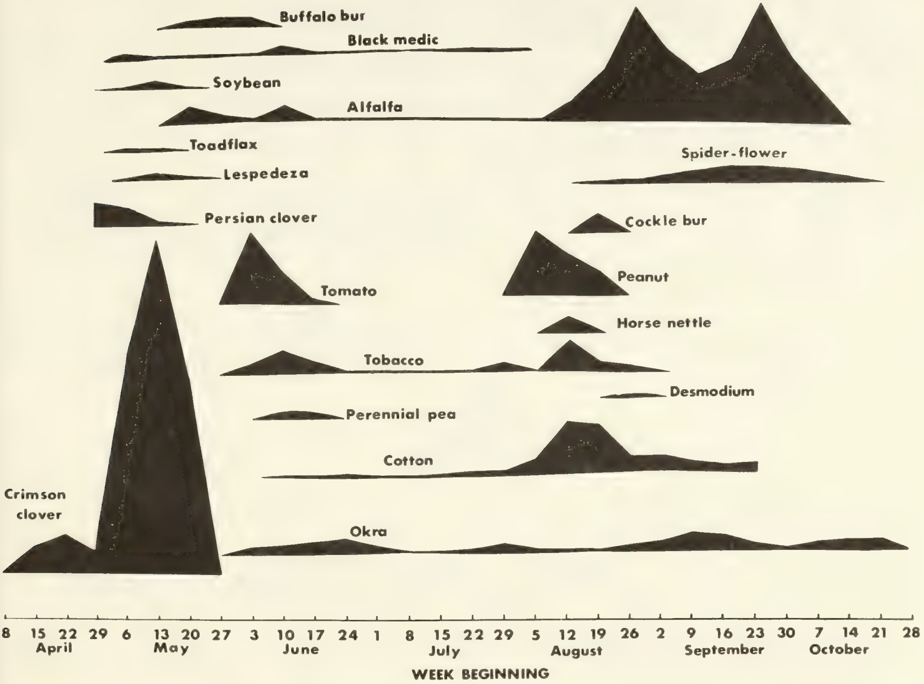

Figure 4. Seasonal host sequence of bollworm larvae on hosts during the entire 1963 season.

RELATIONSHIP OF HOST TO TOBACCO BUDWORM

Data pertaining to seasonal host sequence of this species is presented in Figure 5 in a similar manner as for the bollworm. In this case generations are less distinct in that much overlapping existed making different interpretations possible. It is the view of the writers that 5 complete generations occurred with the first and last taking longer because of the cooler temperatures.

Based on larval records, moths began emerging from overwinter pupae one to two weeks later than recorded for the bollworm. Eggs from this generation were deposited primarily on Persian and crimson clover. Larvae were found on both hosts during the same week but the presence of several advanced instar larvae on Persian clover indicates an earlier occurrence on this plant and places some doubt on the time of first adult emergence. The tobacco budworm showed a preference for Persian clover, infestations reaching a maximum of 40 larvae per 100 sweeps. Seedling tobacco and lespedeza were found to have low but consistent populations of this species. Lespedeza appeared to have the role of a plant suitable as host but not preferred in that only one generation utilized it as a host, even

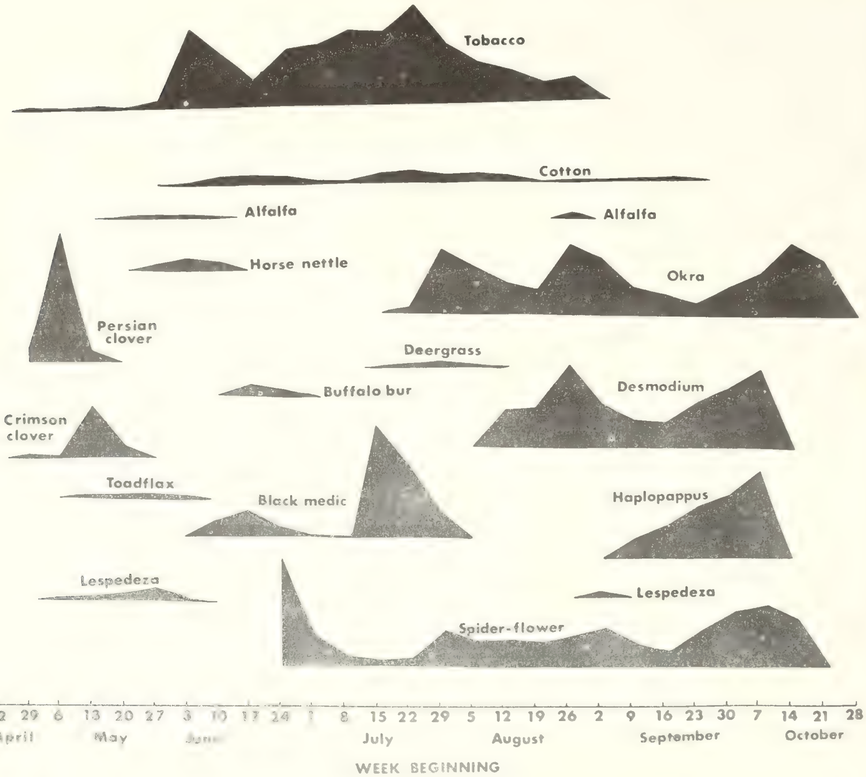

Figure 5 Seasonal host sequence of tobacco budworm larvae on hosts during the entire 1963 season.

though it remained available until late summer. Several plants classed as occasional hosts including buffalo bur, horse nettle and toadflax were utilized during this period. In addition several larvae were collected from alfalfa.

The second generation in June was passed primarily on spider-flower, black medic and cotton. Infestations on cotton and black medic were of low magnitude. Spider flower, first observed during June 24-30 probably had infestations prior to this period. Several of the occasional hosts including buffalo bur, horse nettle and toadflax which were infested in May continued to have small populations in June. Despite the low density of tobacco budworms on these plants, all except buffalo bur are very common in this area and in an overall view probably supported large populations. Tobacco was severely attacked by this generation and remained the preferred host until its destruction in late August. No conclusions can be made regarding this host, however, since it is not native and only a small number of plants were available for oviposition.

The third generation in July was primarily on tobacco, black medic, spider flower, cotton and okra. This generation was responsible for damage to cotton in many fields where automatic insecticide treatment was employed. Deergrass, an important wild host in other areas was only occasionally infested.

The fourth generation occurred in

August and early September on spider flower, tobacco, okra and cotton. Occurrence on cotton for this generation was almost non-existent, averaging less than 1 larva per 100 whole plants. *Desmodium rigidum* was first found infested by this generation and apparently is the preferred host during this period. Additional small populations were recorded on lespedeza and alfalfa.

The fifth and last generation from mid-September thru October again infested *Desmodium rigidum* and another wild host, *Haplopappus divaricatus*. This species reported by Barber (1935) as not supporting particularly large numbers of larvae in Georgia, was found with high populations, comparing with those on *Desmodium rigidum*. No larvae was collected from cotton during this period but they were still abundant on spider-flower and okra. The utilization of these two wild hosts during late season probably accounts for the variation in reports of budworm activity on cotton from areas of Texas (Brazzel and Newton, 1963) as compared with other states (Snow 1963, Young an Brazzel 1963). In the area of Texas under discussion these two wild plant species are absent thus forcing populations to utilize cotton in late season. In the Mississippi situation budworm activity during this period is concentrated on the two wild plant species.

SUMMARY

The bollworm was recorded as attacking a total of 17 species of cultivated plants. Of these, alfalfa, corn, cotton, crimson clover, lespedeza, okra, peanuts, soybeans, spider-flower, tobacco and tomato were found to be of primary importance. Cultivated plants of lesser significance were crotalaria, egg plant, sesame, string beans, sorghum and white clover. This species was recorded feeding on 11 wild species of plants which, in an overall view, played a small role in the seasonal biology. Included species were Desmodium rigidum, black medic, buffalo bur, bur clover, cockle bur, hop clover, horse nettle, Johnson grass, perennial pea, Persian clover, and toadflax.

Tobacco budworms were found on a total of 8 cultivated plant species of which cotton, crimson clover, lespedeza, okra, spider-flower and tobacco were of primary importance. Of lesser importance was alfalfa and sesame. A total of 11 species of wild plants was attacked and apparently these played a much greater role than in the case of bollworms. *Haplopappus divaricatus* and *Desmodium rigidum* were of particular importance in late season. Other infested species were black medic, buffalo bur, cockle bur, deergrass, swamp rose, horse nettle, Persian clover, sweet clover and toadflax.

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ADOPTION OF RECOMMENDED FORESTRY PRACTICES IN THREE MISSISSIPPI COUNTIES

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Adoption of Recommended Forestry Practices In Three Mississippi Counties

INTRODUCTION

A few facts and figures selected from the large body of data on forestry in the state of Mississippi point up the importance of forestry to the economy of the state.[1] Among these are the following:

1. Forest products are responsible for 25 percent of the state's dollar movement, 34 percent of the state's payroll, and 40,000 industrial jobs.
2. Forests represent a $550,000,000 annual industry.
3. Mississippi leads all other states in the production of hardwood pulpwood.
4. Forests occupy 57 percent (17 million acres) of the state's total land area, and they are expanding at an average rate of some 700,000 acres annually.

Relevant to the role that forestry plays in the economy of the state is the preponderance of small woodland tract ownerships. About 75 percent of the forest acres in the state are owned by farmers and other private owners. Statewide wood-using industries own about 15 percent, and the remaining 10 percent is publicly owned. The significance of this distribution of forest tract ownerships, viewed in light of the state's economy, is that "adequate timber management on small private timberland holdings is severely lacking."[2]

Forests owned and managed by wood-using industries and those in public ownership produce twice as many board feet per acre as forests in private holdings. In a 10-county group in south Mississippi, where public and forest industry holdings make up more than 40 percent of the land area, the volume of softwood growing stock increased 23 percent during a 10-year period ending in the late 1950's. In the remaining seven counties of South Mississippi, where farm woodlands and other non-industrial holdings greatly predominate, softwood volume declined 11 percent during the same period.

It seems apparent, therefore, that proper management of timber resources of small holdings could produce significantly more income from forests in the state than is now being produced.

There are conditions, however, which work to the economic disadvantage of owners of small holdings, and these conditions constitute a problem which has received considerable attention from foresters, businessmen, social scientists (sociologists) and economists, and educators. They have studied these conditions with the goal of discovering ways to help solve the problem of under-utilization of forest resources, and thereby help owners of small holdings to improve their economic situation.

One of the factors working against the development of small woodland tracts is the fact that investments of labor and capital in forestry yield much later returns than such investments in crops and livestock. Experiments have shown, however, that even in a 10-year period owners of small woodland tracts can increase their income significantly by following certain recommended practices in relation to their woodlands.[3] For the state of Mississippi as a whole it has been pointed out that a continuation of the build-up in pine inventory, along with proper management of woodlands, would result in millions of additional dollars in the state's economy.

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[1] See, for example, the following brochures: **Facts at a Glance,** Mississippi Forestry Commisson, Jackson, Mississippi (October 1962); **Multiple Use of Our Forests,** Mississippi Forest Industries, Natchez, Mississippi (1963); **Why a Forest Products Utilization Laboratory,** Mississippi Forestry Association, Jackson, Mississippi. See also "Highlights of the Third Forest Survey of Mississippi," mimeographed report of a study conducted by Southern Forest Experiment Station, New Orleans, Louisiana, in cooperation with firms, industries, public agencies, and individuals throughout the state, n. d.

[2] See "Highlights of the Third Forest Survey of Mississippi," **Ibid.,** p. 2.

The rate at which recommended forest management practices have been adopted by owners and operators of small woodland tracts, however, indicates that the prospect of additional income has not proved to be sufficient inducement to lead them to adopt such practices.

This report contains findings of a study of the use of recommended forestry practices with the focus on non-economic factors. The purpose of the study was to identify non-economic factors related to different rates of adoption of recommended practices, and was based upon conclusions drawn from other adoption studies in addition to facts enumerated above. These studies have shown that practices recommended as a result of experiments which have demonstrated their feasibility are not automatically adopted by farmers and homemakers. It seems reasonable to conclude that all such practices must "filter through" a configuration of many factors, any one or more of which may block their adoption. It also seems reasonable to assume that reasons for not adopting such practices may range from rational to irrational, depending on whose scale of values are used as a basis for defining rationality.

In this study, as stated above, the focus is on selected non-economic factors. This is not meant to imply that economic factors are of no importance. On the contrary, it is probable that economic considerations play a vital role in the decision-making process of the individual as he weighs the advantages and disadvantages of using certain forestry practices. The point is that economic factors appear to be part of a configuration of many factors, and that the probability of an increase in income may be less influential in an individual's decision-making process than other factors.

PROBLEM AND METHOD

The specific problem dealt with in this study was an attempt to identify social and cultural factors associated with the adoption of recommended forestry practices. The general hypothesis formulated for the study was that *differences in the rate of adoption of recommended forestry practices are associated with social and cultural differences.*

Data for the study were obtained from schedules used in the study of "Fire-related Attitudes and Characteristics of Forest Residents and other Users in Selected Mississippi Counties."[4]

Three counties in north Mississippi were selected as the area in which field work for the study would be conducted. Selection of these three counties—Carroll, Grenada and Calhoun—was based partly on U. S. Census data and partly on the fact that they are located in the Yazoo-Little Tallahatchie Watershed, one of the largest land reclamation projects in the South. The counties are contiguous, but present contrasts as one moves from the southwest portion of Carroll County to th northeast portion of Calhoun County. The contrasts are seen in (1) ownership patterns, (2) median family income and (3) level of industrialization.

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[3] USDA, Forest Service, **Timber Crops for Southern Farmers** (U. S. Government Printing Office, June 1949).

[4] Field work for this study was conducted in the summer of 1963. Agencies and departments responsible for securing, tabulating and analyzing the data were the Social Science Research Center and the Department of Sociology and Rural Life (both of Mississippi State University) the Federal Forest Service and the State Forest Service of Mississippi.

A random sample was drawn from the list of rural residents in the three counties (excluding households that were located outside the watershed) and the sample units were grouped into five different classes. See Table 1. The first class consisted of persons who were farmers, owners and who had a Soil Conservation Service farm plan made on their farms and filed in The Project Forester's office. The remaining classes become self-explanatory as one studies Table 1.

It was found that 427 of the 751 sample units in the total sample were applicable to the study of adoption of recommended forestry practices. The remaining 324 cases were eliminated from the analysis because the household heads did not hold any acres in woodland and could not be classified as potential adopters of recommended forestry practices.

The dependent variable in this study, rate of adoption of recommended forestry practices, was operationally defined simply as the number of practices adopted from a list of nine practices suggested by professional foresters as being relevant to the area.

The 427 household heads were classified according to the number of practices adopted, resulting in a typology consisting of three classes—Non-adopters, low adopters, and high adopters.[5] The mean number of practices adopted, 2.3, was used as a breaking point with those adopting 3 or more practices classified as high adopters and those using 1 or 2 practices classified as low adopters.

Table 2 lists the nine practices suggested by professional foresters and shows the number of respondents who adopted those practices.

In order to test the general hypothesis, seven specific hypotheses were formulated. For each of these the dependent variable was the same, classification of the 427 respondents as Non, Low or High Adopters. The seven independent variables were (1) education, (2) number of agricultural practices adopted, (3) knowledge about A.C.P. payments, (4) acres in woodland, (5) attitudes toward forestry conservation and investment, (6) contacts with various government service agencies, and (7) sample type.

The seven specific hypotheses were tested statistically by means of the Chi square test of independence with the .05 level of significance as the criterion for acceptance or rejection. An indication of the strength of relationships was provided by calculation of C, the contingency coefficient.

Table 1. Distribution of 751 Sample Cases Among Five Sample Types.

Sample Type	No.	%
1. Farmer-owner, forest cooperator	128	17.0
2. Farmer-owner, forest non-coop.	158	21.0
3. Farmer-renter, forest non-coop.	131	17.5
4. Non-farm owner, forest operator	133	17.7
5. Other, non-farm	201	26.8
	751	100.0

Table 2. Number of Recommended Forestry Practices Adopted by Household Heads in the Three-county Area.

Practices Adopted	Number Adopting
Planted trees to grow timber	178
Made a road through timber	38
Following a plan and schedule for growing and selling timber	34
Removed cull trees	92
Timber measured before making a sale	28
Sold timber on a written contract	70
Selected and marked trees to be cut	27
Received bids on timber before selling	63
Constructed fire lanes	50

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[5] The class of Non-adopters was included in the analysis of data because they were considered as potential adopters in the sense that they owned or controlled woodlands.

ANALYSIS

The first hypothesis tested in this study was *that there is a relationship between education and the rate of adoption of recommended forestry practices.* Education of respondents was defined simply as the number of grades of school completed. For purposes of analysis they were divided into four groups as shown below.

Number of years of school completed	Number*	Percent
1-4	54	12.8
5-8	171	40.6
9-12	163	38.7
16 or more	33	7.9
	421	100.0

*No information on 6 cases.

Studies of characteristics of adopters have shown rather consistently that the more formal education an individual has the more likely he will adopt new practices. That a direct cause-effect relationship exists between education and adoption of practices would hardly be argued by researchers, but that education is one of several variables constituting a causal complex seems highly probably in light of research findings.

Table 3 shows the distribution of the three adopter categories among the four different educational groups. The statistical test indicated that the hypothesis could be accepted.

Thus it was concluded that a significant relationship did exist between education and the rate of adoption of recommended forestry practices. A contingency coefficient of .57 indicated a fairly strong positive relation. That is, as education increases, the rate of adoption goes up.

Although the hypothesis was accepted, it must be pointed out that there were some noteworthy exceptions. It will be noted, for example, that close to 15 percent of the high-adopters had completed less than five grades in school, and that slightly more than 21 percent of the respondents who had completed 13 or more grades of school, i. e., had completed at least one year of college, had adopted no practices. It is also interesting to note that there were just as many low adopters as high adopters in the top educational level, those who had completed 13 or more grades of school.

These exceptions lend support to the argument stated earlier that the adoption of recommended practices is dependent upon a configuration of variables, and that no single factor is in itself sufficient cause for observed differences in the number of practices adopted. The fact that some high adopters were found in the lowest educational group and that some non-adpoters were found in the highest educational group points to the operation of other factors in the decision making process of the respondents.

The second hypothesis tested was that *there is a relationship between the number of agricultural practices adopted and the number of forestry practices adopted by respondents in this study.* Respondents were asked whether they had adopted any one or more of five specified agricultural practices. Of the 256 respondents for whom agricultural practices were applicable, 15 had adopted none of the five specified practices. The mean number of practices adopted by the remaining 241 respondents was 2.8. This was used as

Table 3. Rate of Adoption of Recommended Forestry Practices by Education of 421 Respondents.*

	Education by Grade				
	1 - 4	5 - 8	9 - 12	13 or more	Totals
Adopter Categories	N=54 %	N=171 %	N=163 %	N=33 %	N=421 %
Non-Adopter	46.3	43.9	41.7	21.2	41.6
Low Adopter	38.9	41.5	35.6	39.4	38.7
High Adopter	14.8	14.6	22.7	39.4	19.7
Totals	100.0	100.0	100.0	100.0	100.0

* No information on 6 cases.

a basis for grouping respondents into Low and High categories, and resulted in the distribution shown below.

Number of Agricultural Practices Adopted	Number	Percent
None	15	5.8
1-3	157	61.4
4-5	84	32.8
	256	100.0

When the respondents were grouped according to number of agricultural practices adopted and number of forestry practices adopted, they fell into the distribution shown in Table 4.

It is apparent that a significant relationship did exist between adoption of agricultural practices and adoption of recommended forestry practices. An additional test was conducted taking into account only those respondents who had adopted at least one agricultural practice. This test indicated that the relationship still existed.

A cautious interpretation of this relationship is indicated. That is, until the time sequence of adoption of agricultural and forestry practices can be established it seems logical to assume that a cause-effect relationship could exist in either direction. In other words, successful results from the use of recommended agricultural practices might create a more favorable reception to recommendations from professional foresters with regard to forestry practices, but the reverse might also be true. A third possibility exists, and that is that adoption of agricultural and forestry practices might occur within the same time period.

The fact that a significant relationship was found may be viewed as support of the theory that adoption behavior is part of a typical behavioral pattern. A tendency to adopt new practices soon after they are introduced is characteristic of individuals who typically are under 50 years of age, who are "risk-takers," who actively seek new ideas, who participate in many non-local groups, who have large farms, and whose income is relatively high.[6]

The third hypothesis was that *there is a relationsip between knowledge about A.C.P. payments and the rate of adoption of recommended forestry practices.* Here again the hypothesis was accepted. See Table 5.

It was found in the analysis that more than 80 percent of the high-adopters were aware that A.C.P. payments were available for forestry conservation practices, but that more than 25 percent of the respondents who knew about such payments had not taken advantage of them. Further, almost half of the repondents who were not aware that A.C.P. payments were available had adopted one or more practices recommended by professional foresters.

It is apparent, therefore, that adoption of recommended practices does not depend solely on awareness that A.C.P. payments are available. On the other hand, however, more than 60 percent of those who knew about such payments had adopted one or more practices, whereas only 45 percent of those who were not aware of A.C.P. payments had adopted one or more practices. This pattern seems to fit the adopter ideal type described above.

Table 4. Rate of Adoption of Recommended Forestry Practices by Number of Agricultural Practices Adopted by 256 Respondents.

	Number of Agricultural Practices Adopted			
Adopter Categories	None N=15 %	1 - 3 N=157 %	4 - 5 N=84 %	Totals N=256 %
Non-adopter	13.3	40.8	27.4	34.8
Low adopter	73.3	42.7	35.7	42.2
High adopter	13.3	16.5	36.9	23.0
Totals	100.0	100.0	100.0	100.0

Table 5. Rate of Adoption of Recommended Forestry Practices by Knowledge of A.C.P. Payments of 405 Respondents.

	Knowledge That A.C.P. Payments Were Available		
Adopter Category	Yes N=281 %	No N=124 %	Total* N=405 %
Non-adopters	38.4	54.0	43.2
Low adopters	39.9	35.5	38.5
High adopters	21.7	10.5	18.3
Totals	100.00	100.0	100.0

* Does not include 22 cases of "No Answer."

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[6] See Herbert F. Lionberger, **Adoption of New Ideas and Practices** (Ames, Iowa: The Iowa State University Press, 1960) p. 34.

What might seem to require no more than face validity is the hypothesis that the landowner with a relatively large number of acres in woodland will adopt more forestry practices than the landowner with only a few acres. That such is not necessarily true becomes evident upon inspection of Table 6. The statistical test called for acceptance of the hypothesis, which led to the conclusion that a relationship did exist between the rate of adoption of recommended forestry practices and the number of acres of woodland held by the respondent. There were almost four times as many high adopters proportionately in the 100 acre or more category as there were in the 1-24 acre category. Contrariwise, as the number of acres in woodland increased the proportion of non-adopters in each size category decreased. There were twice as many non-adopters proportionately in the 1-24 acre category as there were in the 100 acre or more category.

Despite the obvious relationship, however, it seems significant that more than a fourth of the respondents with 100 acres or more had adopted none of the recommended practices. Here again is what may be viewed as evidence that a cause-effect relationship is something more than a simple two variable phenomenon. It is obvious that something in addition to size of woodland operated as a causal factor or factors.

The fifth hypothesis tested in this study was that *there is a relationship between rate of adoption of recommended forestry practices and attitudes of respondents toward forest conservation and toward forestry as an investment.* Respondents were classified as having either favorable or unfavorable attitudes toward forestry conservation and investment on the basis of answers to questions contained in the schedule. Of the 427 respondents included in this study, 115 were classified as having an unfavorable attitude toward forest conservation, 302 as having a favorable attitude and 10 as having no opinion or "Don't Know." See Table 7.

The hypothesis was found to be acceptable, and it was observed that respondents with a favorable attitude toward forest conservation were more likely to adopt recommended practices than those with an unfavorable attitude.

This conclusion notwithstanding, it was observed that almost half of the respondents who had expressed an unfavorable attitude toward forest conservation had adopted one or more of the recommended practices. Further, 36 percent of

Table 6. Rate of Adoption of Recommended Forestry Practices by Acres in Woodland.

	Acres in Woodland				
	1 - 24	25 - 49	50 - 99	100 or more	Totals*
Adopter Categories	N=110 %	N=88 %	N=101 %	N=123 %	N=422 %
Non-adopter	58.2	40.9	37.6	27.6	40.8
Low adopter	33.6	50.0	32.7	41.5	39.1
High adopter	8.2	9.1	29.7	30.9	20.1
Totals	100.0	100.0	100.0	100.0	100.0

* Does not include 5 cases of "No Answer."

Table 8. Rate of Adoption of Recommended Forestry Practices and Attitudes Toward Forestry as an Investment.

	Attitude Toward Forestry as an Investment		
	Favorable	Unfavorable	Total*
Adopter Category	N=117 %	N=280 %	N=397 %
Non-adopter	53.0	36.4	41.3
Low adopter	32.5	41.4	38.8
High adopter	14.5	22.2	19.9
Totals	100.0	100.0	100.0

* Does not include 30 cases of "Don't Know".

Table 7. Rate of Adoption of Recommended Forestry Practices by Attitude Toward Forest Conservation.

	Attitude Toward Forest Conservation		
	Favorable	Unfavorable	Total*
Adopter Category	N=115 %	N=302 %	N=417 %
Non-adopter	49.6	37.7	41.0
Low adopter	40.9	37.7	38.6
High adopter	9.5	24.6	20.4
Totals	100.0	100.0	100.0

* Does not include 10 cases of "Don't Know" answers.

those with a favorable attitude had adopted none of the practices.

The relationship between rate of adoption and attitude toward forestry as an investment was only slightly less significant than that between rate of adoption and attitude toward forest conservation. See Table 8.

Here again it is significant that 47 percent of the respondents who expressed an unfavorable attitude toward forestry as an investment had adopted one or more of the recommended practices. Two possible explanations of this condition seem plausible. On the one hand, it might be explained as a function of the particular question asked the respondents with regard to investment in forestry. Respondents were asked whether they agreed or disagreed with the statement that "putting money into trees is a poor investment." It is probable that respondents interpreted the statement in different ways, but the data did not permit an investigation of this probability. On the other hand, it might be that respondents with an unfavorable attitude who had adopted recommended practices had in some way become dissatisfied with the results of the practices.

Despite these exceptions, however, it seems clear that a favorable attitude toward forestry conservation and investment plays a significant role in the decision making process regarding forestry practices.

The sixth hypothesis tested was that *there is a relationship between rate of adoption of recommend forestry practices and number of contacts with agricultural and forestry agencies.*

Respondents were questioned concerning their contacts with eight different government (state and Federal) agencies. The mean number of contacts was 1.84, and respondents were classified on the basis of number of contacts with those having had three or more contacts as High and those with 0-2 contacts as Low.

Table 9. Rate of Adoption of Recommended Forestry Practices by Number of Contacts with Government Agencies.

	Number of Contacts		
	Low	High	Total*
Adopter Category	N=290 %	N=136 %	N=426 %
Non-adopter	47.6	27.9	41.3
Low adopter	36.9	42.6	38.7
High adopter	15.5	29.4	20.0
Totals	100.0	100.0	100.0

* Does not include one case of "No information."

The statistical test of the hypothesis indicated that it could be accepted. See Table 9.

Within the group of high adopters there were almost twice as many proportionately who had three or more contacts as there were who had fewer than three contacts. Referring again to the ideal type of adopter discussed earlier in this report, it is seen that the tendency of high-adopters to have more contacts with government agencies fits the type. That is, if high (or early) adopters characteristically seek new ideas, it is reasonable to conclude that the various government agencies (those pertaining to agriculture and forestry) would constitute an easily accessible source of information.

Again, however, it must be pointed out that not all high-adopters were high "contacters." As stated earlier, the significance of these exceptions is that no single variable is sufficient to explain the adoption or non-adoption of recommended practices.

The final hypothesis tested was that *there is a relationship between rate of adoption of recommended forestry practices and sample type classification of respondents.* Four sample types were used in testing this hypothesis: (1) Farmer-owner, forest cooperator, (2) farmer-owner, non-cooperator, (3) farmer-renter, and (4) non-farm, forest operator. In view of the manner in which sample types were defined, it might seem obvious that a relationship would exist between the variables. That such a relationship did exist was borne out in the statisical test of the hypothesis, but the distribuion of

Table 10. Rate of Adoption of Recommended Forestry Practices by Sample Type.

	Sample Type				
	Farmer-owner Forest cooperator	Farmer-owner Non-cooperator	Farmer Renter	Non-farm Forest cooperator	Totals
Adopter Category	N=128 %	N=144 %	N=22 %	N=133 %	N=427 %
Non-adopter	14.0	48.6	68.2	55.6	41.5
Low adopter	47.7	35.4	31.8	34.6	36.6
High adopter	38.3	16.0	00.0	9.8	19.9
Totals	100.0	100.0	100.0	100.0	100.0

cases as shown in Table 10 shows clearly that to have a forest management plan filed in the federal forest office of the county was no guarantee that recommended forestry practices were being followed.

It will be noted that a large majority of respondents who had a forestry management plan made on their farms and on file in the federal forester's office had adopted one or more of the recommended practices. Of this group of respondents, however, most had adopted fewer than three of the nine recommended practices. This fact could be misleading, however, because of the nature of the nine different practices. It is quite possible, for example, that practices relating to the sale and harvesting of timber were applicable in only a few cases. That is, if the landowner had sold timber in the recent past and subsequently had a forest management plan developed for his woodland, it would hardly be expected that he would have adopted practices relating to the sale and harvesting of timber.

This possibility, as an example, serves to illustrate the complexity of research of this type, and points up needed improvements in research techniques.

SUMMARY AND IMPLICATIONS

This study of social and cultural factors related to the adoption of recommended forestry practices provides additional evidence of the complex character of the decision-making process. It has demonstrated the existence of significant relationships between the adoption of recommended forestry practices and a series of seven variables. All of the hypotheses were accepted, indicating that significant relationships between the dependent variable, rate of adoption, and the seven independent variables did exist. Although the question of causal relationships remains unanswered, this study has shown that the adoption of recommended forestry practices is not unlike the adoption of recommended agricultural and homemaking practices on which considerably more research has focused.

The high adopter, as defined in this study, typically is (1) better educated, (2) adopts more agricultural practices, (3) is better informed, (4) has larger woodland holdings, (5) has more favorable attitudes toward forest conservation and investment, (6) has more contacts with agricultural and forestry agencies, and (7) is more likely to have had a forest management plan developed for his place and on file in the local forester's office than low adopters and non-adopters.

Needed improvements in research techniques were brought to light in this study. In the first place, there is a need to develop more effective data collection instruments, i. e., schedules. One of the major weaknesses of the study was the lack of adequate attitudinal data on respondents. Only a few of the attitudinal items proved capable of eliciting answers sufficiently discriminatory for statistical analysis.

There is also a need for more refined statistical procedures. Use of multivariate analysis or regression techniques should greatly improve the investigation.

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Differential Effectiveness Of Test-Demonstration Farmers

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Differential Effectiveness of Test-Demonstration Farmers

Kenneth P. Wilkinson and Wilfrid C. Bailey[1]

INTRODUCTION

In 1903, Seaman A. Knapp established a demonstration farm in Terrel County, Texas. Since that time, result demonstrations have become one of the educational techniques more widely used by agricultural workers all over the world. The assumption behind result demonstrations is that seeing is believing. If a farmer can be persuaded to use a new practice successfully, his neighbors will see it and try it. Since 1935, the Tennessee Valley Authority and the land-grant colleges have used test-demonstration farms as a means of introducing new fertilizers and improved fertilizer practices. The operators of test-demonstration farms receive fertilizer materials from TVA at incentive prices and managerial guidance from the cooperating extension services for a complete development of farm and home resources.

This project was a part of a Valley-wide approach by TVA and cooperating land-grant colleges to evaluate and intensify the over-all effectiveness of the test-demonstration program.[2] The initial steps in this project were a study of the development of the program in Mississippi,[3] a survey of literature on result demonstrations,[4] and development of techniques for the evaluation of the effectiveness of the program in Mississippi counties.[5]

Objectives

The objective of this phase of the research was the development of improved criteria for the selection of demonstrators. This required (1) measurement of the extent to which demonstrators influence farmers and (2) delineation of social and social psychological factors which contributed to the degree of influence. Understanding of these factors will form the basis for selection of potentially more effective demonstrators in the future.

A demonstration program assumes that new practices and ideas can be diffused throughout a community if they are introduced by key farmers in the area. The change agent, in this case, the cooperative test-demonstration program between Mississippi State University and TVA, channels educational efforts through the demonstrator, rather than attempting to involve every farmer directly. Thus, the choice of demonstrators is crucial to program success.

The selection of an effective demonstrator may be based on criteria which are not always obvious to the casual observer. Random choice of individuals who appear to be outstanding and who are willing to participate has not proven completely adequate. Many times an apparently outstanding individual was an ineffective demonstrator, while often an unlikely prospect proved to have considerable influence upon his neighbors. A check list of personal traits and attributes which make for an influential demonstrator in all situations was needed.

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[1] Department of Sociology and Rural Life, Mississippi Agricultural Experiment Station.

[2] This report is a part of a larger study, "Factors Related to the Selection of Farmers and Demonstrations to Carry Out the Objectives of the TVA Test-Demonstration Program in Mississippi," conducted by the Department of Sociology and Rural Life of the Mississippi Agricultural Experiment Station and the Division of Agricultural Development of the Tennessee Valley Authority in cooperation with the Mississippi Agricultural Extension Service.

[3] Wilfrid C. Bailey and Andrew W. Baird, **Progress Report in Evaluation of the Test-Demonstration Program in Mississippi,** Preliminary Reports in Sociology and Rural Life No. 6, State College: Mississippi Agricultural Experiment Staton, 1959; Wilfrid C. Bailey and Andrew W. Baird, **Evaluation of the Test-Demonstration Program in Mississippi: 1935-1958,** State College: Mississippi Agricultural Extension Service, 1959.

[4] Wilfrid C. Bailey and Andrew W. Baird, **Test-Demonstration and Related Areas: Review of Literature,** Preliminary Reports in Sociology and Rural Life No. 11, State College: Mississippi Agricultural Experiment Station, 1960.

[5] Wilfrid C. Bailey, "Effective Education: Methods and Procedures," **Proceedings of the Agricultural Economics and Rural Sociology Section of the Association of Southern Agricultural Workers,** Annual Meeting, Jackson, Mississippi, February 6-8, 1961. Vol. 1.

Effectiveness of demonstrations may be analyzed in terms of social conditions and characteristics contingent with the demonstration situation. This technique requires less time than more precise psychometric testing of demonstration farmers' personalities and takes account of situational influences which are not the same at all times. Four groups of influences were investigated in the present study as correlates of effectiveness. These were (1) characteristics of the demonstrator, (2) characteristics of his audience, (3) characteristics of the demonstration, and (4) characteristics of the community in which the demonstration was located. Later in the study, principles for the selection of demonstrators were drawn from analysis of these factors.

Methodology

Interviews were obtained from active test-demonstration farmers in four Mississippi counties. The were selected by the project leader in consultation with TVA and Mississippi State University Extension staff members as representative of test-demonstration counties in Mississippi. They included Prentiss and Itawamba Counties within the Tennessee Valley and Forest and Copiah Counties outside. Active demonstrators were defined as those who had participated in the program[6] for two or more years or those who had not been graduated from the program for more than two years. Twenty-nine demonstrators were interviewed. In addition to the demonstrators, a sample of audience farmers was also selected. Five farms were randomly chosen from all farms within two miles of each demonstrator. Each audience farm had 10 or more acres and annual gross sales of $50 or more or had less than 10 acres and gross sales of $250 or more. Usable interview schedules were obtained from 136 audience farmers.

Two types of interview schedules were used. Audience and demonstrator schedules included identical questions on demographic and socio-economic family characteristics and on adoption of recommended farm practices. In addition, audience farmers were asked a series of questions designed to measure the influence of the demonstration program upon their adoption of specific farm practices. The demonstrators were questioned on their knowledge of and involvement in the test-demonstration program.

Characteristics of the Respondents

Demonstrations are normally directed at delineated audiences. From past experience, the young aggressive demonstrator is expected to have little influence upon the practices of his older more established neighbors. Similarly the wealthy planter is seldom affected crucially if his neighbors at a lower socio-economic level adopt a new technique. The flow of communication within a community involves persons who interact as relative equals. The problem for the person who selects the demonstrator is to identify factors which establish or limit equality of interaction.[7]

Gabriel Tardè and other sociologist have maintained that the flow of communication, particularly that bearing new information, is from higher to lower socioeconomic echelons.[8] This may be accepted with one qualification. The flow of information within a locality group is from persons of higher status to persons of lower status *within* a group of relative equals. Serious questions may be raised to the proposition that the very wealthy transmit new ideas directly to the very poor. This applies to attitudinal differences, as well as to socio-economic differences. The highly progressive farmer or innovator influences the moderately progressive farmer, who in turn influences his more conservative neighbor, and so on to the highly conservative farmer or laggard. In each case, the flow is from higher to lower, more to less, but always between persons or groups who are more alike than different.

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[6] The usual participation period for a farmer in the test-demonstration program is five years.

[7] For pertinent literature on communication of agricultural practices, see Bailey and Baird, 1960, **op. cit.;** Herbert F. Lionberger, **Adoption of New Ideas and Practices,** Ames: The Iowa State University Press, 1960; and Everett M. Rogers, **Diffusion of Innovations,** New York: The Free Press of Glencoe, 1962.

[8] Gabriel Tarde, **The Laws of Imitation,** New York: Henry Holt, 1903.

The demonstration program uses a two step flow of communication. The first step is the direct formal dissemination of information from the land-grant college to the demonstration farmer. This is interaction between dissimiliar communicants. Since communication moves most freely between similar communicants, it must be reckoned that the demonstrator's acceptance and adoption of recommendations through the test-demonstration program is motivated by factors other than a recognition of similarities or a personal relationship. The relationship is formal, and therefore it is unnecessary that the communicants be similar in either personal characteristics, motives, or attitudes.

The second step in the flow of information is informal. This is the interchange between the demonstrator and his neighbors or audience. At this point, similar motives, attitudes, and personal characteristics become crucial. The demonstrator and his audience must possess sufficient social characteristics in common so that communication is easily accomplished and relatively free of formality. Such a relationship is not necessarily based upon conscious recognition of ties, such as kinship for instance, although this may be desirable. Rather, interaction is facilitated if the demonstrator and his audience are similar in age, education, social background, and economic standing.

The importance of similarity in informal interaction has been demonstrated by studies dealing with sources of farm information.[9] Friends and neighbors are consistently named as important sources for one another. Complete dependence upon friends and neighbors for information, however, is correlated with the tendency to make few actual changes in farm practices. In such cases, the flow of communication is circular; the communicants rely upon one another, and outside sources are neither recognized nor exploited. The demonstration program attempts to break the chain, so to speak, by interjecting new information into the circle of communication through the demonstrator.

Three prerequisites to success at this stage of the communication process are (1) that a strong motivational tie exist between the change agent and the demonstrator, (2) that the demonstrator be adequately instructed with respect to new information, and (3) that a basis for the communication of new information between the demonstrator and his audience exists potentially. The third requirement, which is the central focus of this study, may be met when two conditions exist. First, the demonstrator must be an accepted participant in the local communication cycle, and second, the demonstrator must be slightly atypical of the group. His atypicality must not, however, be so marked as to isolate him from the cycle of informal communication.

The demonstrators interviewed differed considerably as a group from the sample of audience farmers. Table 1 shows important differences on a series of personal and economic characteristics. For instance, a greater percentage of demonstrators lived on hard-surface roads in houses rated by the interviewer as being in good condition. A greater percentage of demonstrator families had preschool children, children in school, and other children at home. The median houseold size of the demonstrator group was longer, with the heads and homemakers of the households being younger and more highly educated.

With the exception of median nonfarm

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[9] Rogers, op. cit., pp. 208-253.

income, the demonstrators scored higher on all measures of family financial status, especially with respect to gross farm income. Differences in livestock sales primarily accounted for the higher farm income. Demonstrators had a median annual income of $4,856 from livestock sales while audience farmers had $681. Demonstrators had medians of 74 acres in cropland, 73 acres in pasture, 49 acres in woodland, and 259 total acres. Audience farmers had medians of 34 acres in cropland, 21 acres in pasture, 21 acres in woodland, and 238 total acres. Farm size differed only slightly, but the demonstrators had considerably more crop and pasture land. In total net family income, the demonstrators ranked much higher.

Demonstration families' higher incomes and larger crop and pasture land holdings were reflected in higher material levels of living. Level of living was measured by a scale of 14 consumption items devised through trace line (item) analysis. The items in the scale included automobile and pickup, telephone, three-speed record player, television set, home freezer, air conditioner, vacuum cleaner, electric sewing machine, automatic washer, radio, piped water, kitchen sink, daily or weekly newspaper, and magazine subscription. The median number of these items possessed by demonstrator families was 10.2; while audience families had a median of only 8.1 items. Such a difference, in light of the relatively small number of items in the scale, indicated a distinct variation in level of living between the two groups.

Formal social participation was also different for the two groups. Demonstrators and their wives were more likely to be active in both religious and secular organizations. Over two-thirds of the demonstrators and one-half of their wives were active in religious and secular activities as compared with one-third of the audience farmers and one-fourth of their wives. Participation in religious and secular organizations was one of several characteristics including lower age, higher education, and higher economic status which distinguished demonstrators from their neighbors.

These comparisons indicate that as a group demonstrators differed from audience farmers. Since communication is fostered by similarity one might question the potential effectiveness of the demonstrators as transmitters of information to their dissimilar neighbors. The comparisons, however, have been between groups, rather than between individuals or families. In the second section of this report, the effectiveness of each demonstrator in influencing his audience is evaluated. In the third section the relationship between the demonstrator and his specific audience is investigated.

Table 1. Selected Characteristics of Audience and Demonstrator Families.

Characteristics	Audience (N=136)	Family Demonstrator (N=29)
House exterior in good condition (percentage)	34	48
Residence on hard-surface road (percentage)	29	45
Consists of married couple (percentage)	92	97
Family head fully able to work (percentage)	88	100
Have preschool children (percentage)	15	24
Have children in school (percentage)	40	76
Have other children in home (percentge)	35	48
Number of persons in household (median)	3.4	5.3
Age of household head in years (median)	56.4	43.9
Age of homemaker in years (median)	50.9	42.0
Education of head in years (median)	9.4	11.9
Education of homemaker in years (median)	9.2	11.9
Land holdings in acres, 1960 (median)	238	259
Non farm income* (median)	$2,778	$2,600
Gross farm income (median)	3,302	9,249
Total net family income**	2,306	4,112

*Includes only families (81) with some nonfarm income. Among these are 44 percent of the audience farmers and 62 percent of the demonstrators.

**Based upon respondents' estimates of net income.

EFFECTIVENESS OF THE DEMONSTRATORS

Effectiveness refers operationally to the influence a demonstrator has upon his immediate audience. Two measures of effectiveness are (1) the actual adoption by audience farmers of demonstrated practices and (2) recognition by audience farmers of the demonstration as an influence upon their decision to try a new practice. These are limited measures of effectiveness, since audience farmers may be at different stages of the adoption process. Some have an awareness of a new idea, others have evaluated it, others have tried it, and others have adopted it. Further, audience farmers may be influenced by a demonstration without formally recognizing the demonstrator as a source of information. Results from these measures were not adjusted for such factors as the difficulty of adpotion of the practice, difficulty to observe results of the demonstration, appropriateness of the practice for adoption on audience farms, and the attitudes of the audience toward the particular change.

Sixty-five percent of the audience farmers had adopted the demonstrated practices. Fifty-six percent of these said they learned about the practice from their own experiments, and seventy-two percent said the promise of better yield influenced them to try it. Only nine farmers reported having learned about the practice from a demonstration. The relatively high rate of actual adoption indicates that the influence of demonstrations could have been more important than recognized by the audience farmers.

The most straight-forward indicator of a demonstrator's effectiveness is whether or not his neighbors have adopted practices he is demonstrating. In 10 cases all the audience farmers interviewed had adopted the demonstrator's practice; in 10 cases more than sixty-one percent of the demonstrator's neighbors had adopted his practice; and in 9 cases fewer than sixty-one percent of the demonstrator's neighbors had adopted his practice. The three groups of demonstrators were ranked as high, intermediate, and low, respectively, in rate of practice dissemination.

Demonstrators ranking high, intermediate, and low in rate of practice dissemination were expected to differ in significant ways. The remainder of the report deals with these differences. From the analyses of differences, principles for improved selection of demonstrators have been developed.

FACTORS RELATED TO RATE OF PRACTICE DISSMINATION

The criteria for selecting an effective demonstrator must include consideration of his personal attributes, characteristics of his audience, the nature of the demonstration, and characteristics of his community. Each of these is investigated in this section. With the objective of defining causes for differential levels of effectiveness, demonstrators ranked high, intermediate, and low in rate of practice dissemination are compared as are audience farmers who have and who have not adopted demonstrated practices.

The Demonstrators

The demonstrator with a high rate of dissemination differed from the less effective one in several ways. Personal attributes, such as age, education, and economic success gave him greater status in the eyes of his audience. More subtle factors, such as his knowledge of the test-demonstration program and his motivation to fulfill its objectives affected the way he responded as a source of information for other farmers.

Demonstrators with a high rate of prac-

Table 2. Comparison of Demonstrators and Audience Farmers at Three Rates of Practice Disseminaton.

	Rate of Practice Dissemination					
	High		Intermediate		Low	
Characteristics	Demonstrator	Audience	Demonstrator	Audience	Demonstrator	Audience
	(N=10)	(N=50)	(N=10)	(N=50)	(N=9)	(N=44)
Median Age in Years	44	54	47	53	41	58
Median Education in Years	11	9.3	11	9.4	Over 12	9.4
Median Total Family Income	$3,999	$1,499	$3,199	$2,739	$4,750	$2,812
Median Level of Living Score	9.8	7.0	11.5	9.1	11.4	9.3

tice dissemination were similar to their neighbors in age and education but not so similar as were demonstrators with intermediate rates. Demonstrators rated low were much younger and more highly educated than their neighbors. Table 2 shows a curvilinear pattern of effectiveness for these two characteristics.

Demonstrators with high rates of dissemination had a median total family income higher than those with intermediate rates but lower than those demonstrators who ranked low on practice dissemination. Level of living scores for the demonstrators with high rates of dissemination were lower than for the other two groups of demonstrators, and audience families living near demonstrators with high rates tended to have lower level of living scores. Demonstrators with high rates of dissemination were more like their neighbors than were those rated low.

Demonstrators rated high were neither the most similar to their neighobrs nor the most different. They were between these—more like their neighbors than different, but not so much like their neighbors as to be typical of them. This supports the earlier stated contention that effective demonstrators are so similar to their neighbors as to be accepted associates but still are slightly atypical.

The intermediately rated demonstrators were most like their neighbors. Information was collected on the adoption of four recommended practices which were being promoted in the general extension program. These were (1) thick spacing of corn (13" to 18" apart to a drill) on better land, (2) use of hybrid seed corn, (3) use of certified cotton seed no more than two years removed from the breeder, and (4) having soil tested at least once every five years. Demonstrators with high rates of dissemination had adopted an average of 3.2 of these four practices; intermediate demonstrators averaged 2.9 adoptions; while those rated low had adopted 3.2 practices. Average audience adoptions at these three levels were 2.3, 2.2, and 2.0, respectively. The greatest similarity was between intermediately effective demonstrators and their audience; the greatest difference was between those rated low and their audience. Demonstrators with high rates of dissemination were intermediate in similarity to their audience.

A majority of the demonstrators with high rates of dissemination had farm holdings ranging from 150 to 400 acres. Seldom were they on farms larger than 400 acres. One-third of the demonstrators ranked low had holdings of 400 acres or more as compared with only one-tenth of the highly rated demonstrators. Only one demonstrator with a high rate of dissemination had fewer than 150 acres.

Demonstrators were apparently most effective during their fourth year of participation in the program. The median length of participation for demonstrators with high rates of dissemination was 4.3 years. Demonstrators rated intermediate had participated longer (median — 4.5 years) and those rated low had been in the program for a shorter period (median — 3.8 years). The median length of participation for all demonstrators was 4.3 years.

Demonstrators with the highest rates of dissemination tended to give less specific reasons for their selection in the program. Those giving no specific reason included 70 percent of the highly rated demonstrators and sixty percent of the intermediately rated. Seventy-eight percent of the demonstrators with low rates of adoption listed a reason for their selection, with over half saying willingness to try new practices was the most important reason. Willingness to try new practices is a distinguishing characteristic of the innovator. Verbalization of this trait as a primary reason for being selected for program participation likely accounts for the low rate of practice dissemination from these farms. None with high rates of dissemination indicated that willingness to try new practices was a factor in their selection.

Willingness to change, of course, is a necessary prerequisite to becoming a demonstrator, or even an adopter. The individual whose personality is almost completely centered around this trait, however, makes a relatively uninfluential demonstrator. Apparently the most influential demonstrator is willing to change but not particularly eager to do so. One hypothesis for future study is that the farmer who volunteers to be a demonstrator is less likely to be effective than one who shows no reluctance but must be enticed.

Few differences on measures of personal involvement in the test-demonstration program exist between high, intermediate, and low levels of practice dissemination. All the demonstrators knew who was in charge of the program, but only four gave an accurate estimate of the number of demonstrations in their counties. Seventy-nine percent listed county wide improvements which had resulted from the program; seventy-two percent had specific goals or objectives for their farms; and ninety percent reported keeping records of demonstration activities. Twenty-six demonstrators listed advantages of being a demonstrator and only seven listed any disadvantages. These indices of involvement were unrelated to effectiveness, although more than half the highly effective demonstrators listed no objectives and more than half of those who were low in effectiveness listed increased income as a specific goal.

The foregoing analysis revealed a persistent pattern which should be of value in choosing demonstrators. The most rapid spread of practices was from demonstrators who were more like their neighbors than those with the slowest spread of practices. Demonstrators who were intermediate in rate of spread of practices were even more like their neighbors. Apparently, similarity to neighbors contributes to rapid spread of practices to a certain point and then its contribution diminishes. This is explained by communications theory. Information flows most easily within a homogeneous group, and most effectively between an outstanding group member and the other group members. As stated earlier, the demonstrator must be an accepted group member, but he must also be outstanding.

Audience Farmers

The rate of spread of practices from demontrations is affected by characteristics of audience farmers. While characteristics of demonstrators and the similarity of a demonstrator to his audience are important, the audience farmers themselves remain as the final link in the dissemination and adoption process. In this section audience farmers who had adopted demonstrated practices are compared with those who had not.

Careful selection of audience groupings is equally as important to a successful demonstration program as is selection of demonstrators. The typical audience farmer is likely to be influenced by someone who slightly outranks him in socio-economic standing. Two extreme groupings of audience farmers do not react according to this generalization. The innovator, at one extreme is so eager to try new things that he is influenced despite dissimilarities between himself and the demonstrator. At the other extreme, the laggard is resistant to even the most carefully devised demonstration program. Identification of these two groups is an important consideration in choosing sites for demonstrations.

Audience farmers who had adopted practices demonstrated on test-demonstration farms had also adopted other generally recommended practices. Table 3 illustrates this for four recommended practices. Eighty-four percent of those adopting demonstrated practices had adopted more than one other recommended practice. New information is introduced most effectively when audience farmers are accustomed to the adoption of recommended practices. Demonstrations are most immediately effective if located in areas where receptiveness to new ideas has been proven.

Farmers who had adopted demonstrated practices had a lower median age, higher education, and slightly higher level of living—indicating that they had somewhat higher socio-economic standing than farmers who had not adopted demonstrated practices. This finding, shown in Table 4, has been corroborated by studies dealing explicitly with the adoption process and needs little elaboration here.[10]

Although the two groups differed only slightly, adopters of demonstrated practices were more likely to go beyond friends and neighbors for authoritative sources of farm information. Table 5 shows that mass media, such as newspaper, radio, and television were used as sources of information more by adopters than nonadopters and that nonadopters tended to rely slightly more on friends and neighbors. A larger percentage of nonadopters named county extension agents as primary sources of information. All who listed extension or experiment station bulletins as primary sources of information had adopted the demonstrated practices. This indicates that more attention needs to be placed on transferring results of demonstrations through bulletins and methods other than personal contact.

Most audience farmers agreed that the idea of demonstrations was a good one, but few indicated that they were influenced by the demonstrations being conducted. Table 6 indicated nonadopters had more knowledge than adopters on eight measures of contact with the program. Both groups indicated a low general level of knowledge of the program. When names of all the demonstrators in the county were read to the audience farmers, sixty-two percent failed to identify any as demonstration farmers. The demonstrators were known as farmers and

Table 3. Adoption of Other Recommended Practices by Adopters and Nonadopters of Demonstrated Practices Among Audience Farmers.

Number of Recommended Practices Adopted*	Adoption of Demonstrated Practices	
	Adopted	Not Adopted
	(N=94)	(N=42)
0-1	16%	34%
2-3	69	64
4	15	2

*The practices are thick spacing of corn, use of hybrid seed corn, use of certified cotton seed, and having soil tested every five years or less.

Table 4. Selected Characteristics of Adopters and Nonadopters of Demonstrated Practices Among Audience Farmers.

Characteristics	Adoption of Demonstrated Practices	
	Adopted	Not Adopted
	(N=94)	(N=42)
Median Age in Years	53.1	57.8
Median Education in Years	9.5	8.9
Median Level of Living Score*	9.1	8.9
Median Family Income	$2,162	$2,857

*Median number of possessions of 14 consumption items.

Table 5. Primary Sources of Farm Information for Adopters and Nonadopters for Demonstrated Practices Among Audience Farmers.

Source of Information	Adoption of Demonstrated Practices	
	Adopted	Not Adopted
	(N=94)	(N=42)
Mass Media	26%	24%
County Extension Agent	21	26
Neighbors and Friends	19	22
Agricultural Bulletins	6	0
Other	28	28
Total	100	100

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[10] Lionberger, op. cit., pp. 96-104.

often as good farmers, but they were seldom recognized as test-demonstration farmers.[11] Adopters and non-adopters shared this characteristic.

The evidence indicates that farmers who adopt demonstrated practices are likely: (1) to have adopted other recommended practices, (2) to be younger, more highly educated, and have higher levels of living than their neighbors, (3) to go beyond friends and neighbors in seeking farm information, and (4) to read written reports and listen to mass media. Neither adopters nor nonadopters had had extensive contact with the demonstration program, but nonadopters had most contact. Similarity between audience member and demonstrator remained as the most crucial factor in whether or not information was disseminated effectively although audience characteristics, per se, were important. Even though nonadopters were more familiar with demonstrators and the test-demonstration program than adopters, they had not been motivated to adopt by either demonstrations or other methods.

Table 6. Knowledge of the Test-Demonstration Program by Adopters and Nonadopters of Demonstrated Practices Among Audience Farmers.

Item	Adoption of Demonstrated Practices	
	Adopted	Not Adopted
	(N=94)	(N=42)
Said "Demonstrations Are Effective"	73%	76%
Knew of a Demonstration	36	36
Named a Demonstration	31	33
Named T-D Objectives	29	31
Named T-D Accomplishments	24	24
Name Qualifications of Demonstrators	16	17
Visited a T-D Farm	13	14
Visited a Demonstration	13	12

Table 7. Practices Demonstrated and Rate of Practice Dissemination of Demonstrators.

Practices Demonstrated	Rate of Practice Dissemination		
	High	Intermediate	Low
	(N=10)	(N=10)	(N=9)
Corn Fertilization	70%	30%	—
Pasture Fertilization	10	70	89%
Oats Fertilization	10	—	—
Truck Crop Fertilization	10	—	—
Corn Irrigation	—	—	11

The Demonstrations

Characteristics of the demonstration partially account for the rate of adoption of the practice. Planning, publicity, and skill in carrying out demonstrations bear heavily upon their results. The timeliness and appropriateness of the demonstration within the agricultural setting of the locality is also important. Moreover, there is evidence that demonstrations of certain practices are more likely to result in adoption than others. The selection of demonstrators should involve at least a recognition of the demonstration's effect upon the demonstrator's success.

Demonstrations of corn fertilization were more often followed by the audience than were demonstrations of pasture fertilization. The 10 corn fertilization demonstrations in the sample were carried out by seven demonstrators who ranked high in rate of practice dissemination and three who ranked intermediate. Table 7 shows that only one of the sixteen pasture fertilization demonstrations was on a farm of a demonstrator in the group ranked highest. Fertilization of oats and truck crops was adopted by all the farmers in the areas where they were demonstrated. It may be hypothesized that fertilization of corn, oats, and truck crops fit the predominant pattern of agriculture in the sample counties more than does pasture fertilization. Pasture fertilization denotes a significant transition for many farmers from traditional crop cultivation to livestock production. Thus, of the demonstrators who were copied, most demonstrated a practice which was in keeping with dominant current norms. Adopted practices were such that results were more easily demonstrated and adoption did not require complicated changes in the farming program. Practices such as corn fertilization involve minor changes and are thus accepted more readily.[12] Demonstrations are more often copied if they introduce practices which are slight modifications of accepted practices. Radical changes are often resisted rationally and irrationally.

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[11] The same conclusion was drawn after interviewing 54 persons in agriculture-related businesses living in towns within the sample counties. All respondents recognized more than one-half the names as farmers, but only one person recognized more than one-fourth of the names as demonstrators.

The one obvious innovation in the sample was met with little acceptance. Irrigation of corn was adopted by none of five audience farmers in the area where it was demonstrated. Three of the farmers were acquainted with the demonstration program; four knew its objectives; and two were aware of the demonstrator's participation in the program. The nature of the demonstration in this case largely accounted for the absence of adoption by audience farmers.

Rate of adoption of a practice reflects both the difficulty of the practice and the effectiveness of the demonstration. No attempt was made to determine the rationality of adopting difficult practices.

The Communities

Community characteristics may influence the rate of adoption of demonstrated practices, since communication patterns often follow the network of interaction which structures a local society. A demonstration program may be more successful if it becomes intermeshed with the informal communication structure of the community. Then too, the ecological structure of the community—where people and economic centers are located spatially—influences whether or not a demonstration is seen often by audience farmers. Both of these factors should be considered in choosing demonstrators. Two types of data are available for evaluating the influence of community characteristics on demonstration effectiveness: (1) similarity of community identification between demonstrator and the audience farmer and (2) ecological location of the demonstration farm.

Table 8. Community Identification and Adoption of Demonstrated Practices Among Audience Farmers.

Community Named as Place of Residence	Adoption of Demonstrated Practices	
	Adopted (N=89*)	Not Adopted (N=39*)
Same as Demonstrator	62%	56%
Other than Demonstrator	38	44

*No information for five adopters and three nonadopters.

Table 9. Likelihood of Passing a Demonstration While Traveling to a Trade Center for Adopters and Nonadopters of Demonstrated Practices Among Audience Farmers.

Likelihood of Passing a Demonstration	Adoption of Demonstrated Practices	
	Adopted (N=94)	Not Adopted (N=42)
Probably Pass T-D Farm	33%	29%
Probably Not Pass T-D Farm	67	71

Demonstrations were more effective in situations where audience farmers and demonstrators agreed on community identification. Table 8 shows that sixty-two percent of the audience adopters of demonstrated practices named the same community as the nearest demonstrator. Multiple names for rural neighborhoods notwithstanding, common identification with a single locality indicated increased communication between the demonstrator and his audience.

The effectiveness of a demonstration was directly related to its location. Farmers adopting demonstrated practices were more likely to pass demonstration farms en route to trade centers Audience farmers were asked where they bought groceries, clothing, furniture, and farm supplies, where they sold farm products and where they banked. The town named the greatest number of times by each respondent was regarded as his major trade center. Judgments were made, using county highway maps, as to whether or not travel to the major trade center would take audience farmers by the demonstration farms. Table 9 shows that thirty-three percent of the adopters and twenty-nine percent of the nonadopters probably passed a demonstration farm regularly. The closer to town the demonstrator lived, the more likely his farm would be observed by audience farmers. This presented the opportunity for more exposure of his demonstration to the audience.

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[12] Because the farmers were asked to name what they had demonstrated, it was not practical to determine the exact manner in which they had carried out the demonstration. This is a variable that needs investigation.

SUMMARY

This is a study of the test-demonstration program in Mississippi. The objective is to develop more adequate criteria for the selection of effective demonstration farmers. The demonstration process is analyzed as a two step flow of communication—(1) from the land-grant colleges to the demonstrator and (2) from the demonstrator to his neighbors. The central concerns of the paper are factors which facilitate or impede the adoption of practices by the demonstrators' audience.

Twenty-nine demonstrators and 136 audience farmers were interviewed. The audience farmers were chosen randomly from within a two-mile radius of the demonstrators. As a group, the demonstrators were younger, more highly educated, had higher levels of living, and had more profitable farm operations than the audience sample.

Demonstrators were divided into three groups depending on the percent of audience farmers that had adopted the demonstrated practice; one hundred percent of the audience had adopted the demonstrated practice of 10 demonstrators; sixty-one to ninety-nine percent had adopted the practices of 10 farmers, and sixty percent or less of the audience had adopted practices of 9 of the farmers.

The demonstrator in the group where all practices demonstrated were adopted by the audience was similar to his audience, but not so similar as were demonstrators of intermediate effectiveness.

This was the finding with regard to age, education, level of living, and level of adoption. The highly effective demonstrator had a medium sized farm (150-400 acres) and had been a demonstrator for more than four years. He had a willingness for change and trying new practices, although this was not his dominant personality trait. The effective demonstrator was enough like his neighbors to be accepted as an associate, but outstanding enough to serve as a reliable source of information.

Characteristics of audience farmers, demonstrations, and communities were found to contribute to rate of adoption of practices. The effective demonstrator influenced farmers who were most receptive to new ideas. Such farmers had lower ages, higher educations, and higher levels of living. They had adopted other recommended farm practices, and their eagerness to try new things tended to take them beyond friends and neighbors in search of information.

The nature of the demonstration contributed to the demonstrators' influence in disseminating practices to neighboring farms. Demonstrations of corn fertilization were adopted more frequently by audience farmers than the less accepted practices of pasture fertilization and corn irrigation. Finally, community identification of the demonstrator and audience farmer, as well as location of the demonstration were related to other farms, contributed to the rate of diffusion and adoption of practices.

Guidelines for the selection of demonstrators were drawn from the analysis. To have a successful program one should choose farmers who have the following characteristics:

1. Be willing to be selected as a demonstrator but not so anxious to be a demonstrator as to aggressively seek the position.
2. Be willing to accept new ideas from others but not be an innovator himself.

3. Be slightly younger than the audience.
4. Have slightly more education than the audience.
5. Have slightly higher farm income than the audience.
6. Have a slightly higher level of living than the audience.
7. Although outstanding, not be so different in characteristics as to be considered by the audience as different from them.
8. Be a recognized leader in religious and secular groups attended by his audience.
9. Be located so the audience frequently passes his farm.
10. Be located in areas where audience farmers are accustomed to adopting recommended ideas.

Bulletin 715 August 1965

Climatological and Solar Radiation Relationships

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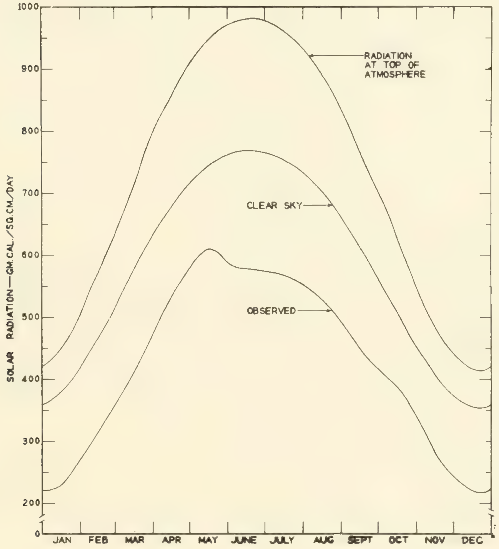

Figure 1. Radiation at Top of Atmosphere, Clear Sky Radiation, and Received Solar Radiation

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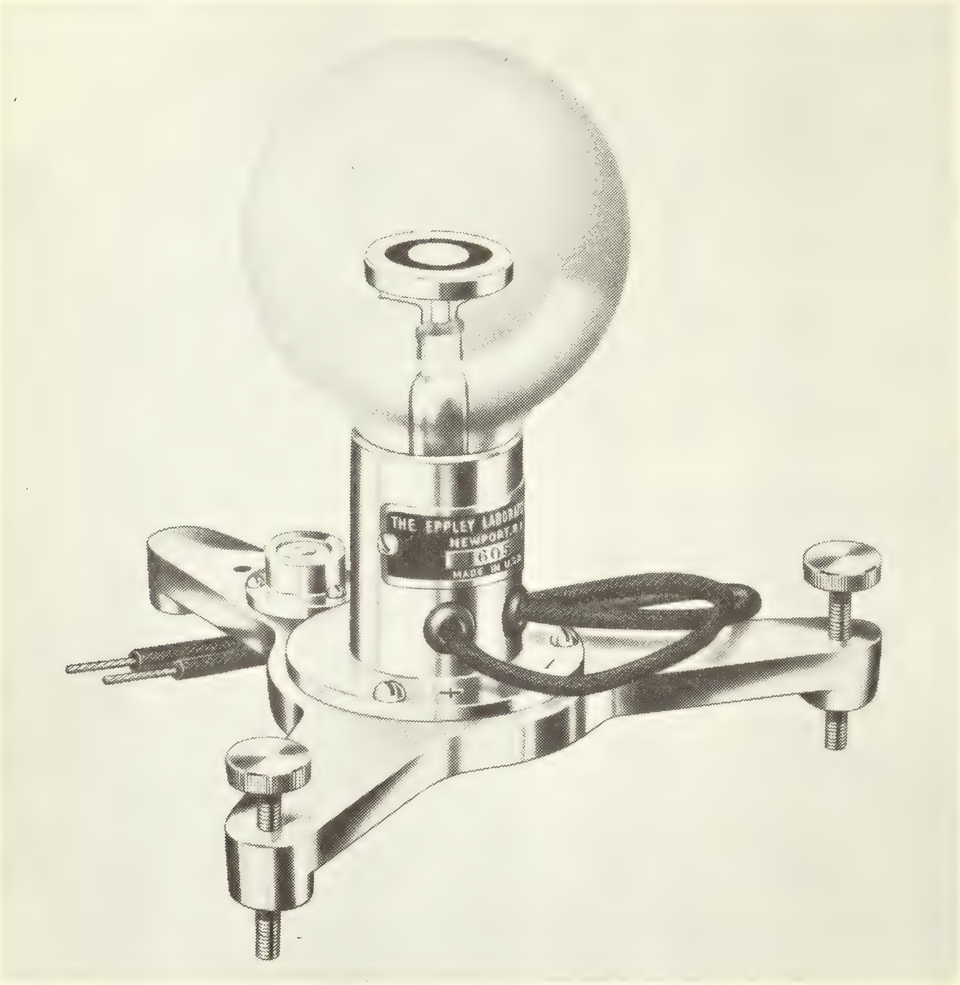
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Figure 2 - Eppley Pyrheliometer, Weather Bureau type

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One of the most important but least known aspects of meteorology is solar radiation and its effect on the weather. The cause of almost all weather variation can be traced back to solar radiation. Irving F. Hand, long-time director of solar radiation research for the United States Weather Bureau, may even have understated the importance of solar radiation in relation to the weather when he said:

> "Radiation from the sun is the ultimate source of all except a practically negligible portion of the continual supply of energy that is essential for the maintenance of plant and animal life on the earth and for the operation of nearly all natural phenomena on the surface of the earth; in particular, the amount and distribution in time and space of the solar radiation which is intercepted by the earth is the primary generating cause of the physical activities in the atmosphere that determine weather and climate. The study of radiation from the sun is therefore of direct and fundamental importance to numerous different fields of both pure and applied science." (2)

There has been no real effort on the part of man to harness solar energy for power development or other conversions of energy. He appears to be content to rely on solar radiation to supply the energy for biological processes. Thus, he harvests only a small fraction of this vast energy supply for immediate use.

Since our capital energy supplies are being used at an ever-increasing rate, new sources of power are always under investigation. Solar radiation is becoming of increased interest as a source of power. Already several solar furnaces and engines have been built with varying degrees of success. Other researchers have been studying the problem of heating and cooling homes by the utilization of solar energy. Recently, research has been conducted toward converting solar energy directly into electrical energy, and a solar cell has been developed. The future developments for the utilization of solar energy are limited only by man's ingenuity and ability.

Considerable research is also being conducted in the study of soil temperature and its relation to plant growth. Getting a good crop stand depends largely on soil moisture and soil temperature. It is easy to see whether the soil is too wet or too dry, but it is not as easy to see if the soil is too cold. Researchers today are studying the problem of determining the best soil temperature for planting various crops. For example, researchers in the Mississippi Delta have shown that to assure a good rate of seed germination of cotton, the mean two-inch soil temperature should average 68° F. or higher for ten days after the planting date. (5) Future research in this field will undoubtedly pave the way for better crop stands.

PURPOSE OF STUDY

The purpose of this study is twofold - to present weather records of the weather station at State College, Mississippi, and to offer methods of estimating certain of the climatic variables when others are known.

In many areas in the Mid-South there are no weather stations measuring solar radiation and soil temperatures. The farmer, research worker, or engineer in these areas might need methods of calculating and estimating with reasonable accuracy the soil temperature and solar radiation. This paper offers methods of calculating weekly values of soil temperatures and solar radiation when other weather information is known.

It was observed through examination of the weather records and graphs such as Figures 4, 6, and 8 that solar radiation tends to follow a straight-line relationship with other climatological variables. All the calculations in this paper are based on the assumption that solar radiation does have a linear relationship with these other variables. The possibility of curvilinear relationships was not investigated, although future research in the field should probably be directed toward this question.

COLLECTION AND PROCESSING OF DATA

All the data for this study were obtained from the records of the Mississippi State University weather station and consist of data on solar radiation, pan evaporation, wind movement, air temperature, and soil temperatures at 2, 4, 8, and 16 inch depths. All of these data except the solar radiation information are published monthly in the U. S. Weather Bureau's publication, Climatological Data - Mississippi.

Measurement of solar radiation was made by a 10 junction Eppley pyrheliometer (Figure 2) and a Leeds and Northrup recorder designed to record solar radiation in gram calories per square centimeter. The sensing element of the pyrheliometer consists of two concentric rings one coated with lampblack and the other smoked with magnesium oxide. When exposed to solar radiation, the two rings develop a marked temperature difference, and the resulting voltage is nearly proportional to the intensity of solar radiation. The recorder is equipped with an integrator which indicates accumulated solar radiation on a numbered dial. The recorder also produces a strip-chart record of the intensity of solar radiation.

The evaporation, wind movement, and air temperature data were collected in the manner prescribed by the Weather Bureau, using a Class A evaporation pan, a standard Weather Bureau anemometer, and maximum and minimum thermometers. The soil temperature measurements were taken under bare ground using two Taylor temperature recorders.

The results in this study are based on weekly values of the weather data. A total of 241 weeks was used; however, fewer weeks of soil temperature records were available. The average daily value for the week of each variable was used in the computation. These averages are tabulated in Table 4.

Most of the computations were made by the Mississippi State University Computing Center on an IBM 1620 digital computer using the General Foods Multiple Regression Package program. The data were fed into the computer using solar radiation as the dependent variable and all the other data as independent variables. The computer eliminated some of the variables which were closely correlated with other variables and developed an equation using all the remaining variables. An equation was then computed using the one most significant variable. Some of the data were then fed back into the machine to get equations with certain combinations of independent variables which were not included in the first run. A few of the calculations were made by hand on a desk calculator.

It should be kept in mind that the formulas presented in this study were computed from data obtained at State College, Mississippi (lat. 33°28', long. 88°48'), and it is not known how well these formulas can be applied in areas at different latitudes and with different climatic conditions.

CLEAR SKY RADIATION

The graph in Figure 1 shows three curves. The top curve is the amount of solar radiation received at the top of the atmosphere. The values for this curve were obtained from Smithsonian Meteorological Tables, sixth edition, and computed for the latitude of State College, Mississippi (33°28').

The middle curve represents the maximum amount of solar radiation which might be expected at the earth's surface on a given date. This curve was computed from maximum values of solar radiation received at State College and is related to the radiation at the top of the atmosphere by the following equation:

$$Rsc = .73245Rsx+50.6 \qquad [1]$$

where Rsc is clear-sky radiation and Rsx is radiation at the top of the atmosphere.

The bottom curve represents the actual amount of solar radiation received at the earth's surface and was plotted from monthly averages of solar radiation which are shown in Table 2.

The difference between the top two curves is due to the normal filtering and absorbing effect of the atmosphere, due mainly to invisible water vapor in the air. The difference between the two bottom curves is due to clouds and other impurities in the atmosphere. This study shows that an average of about 80.3 percent of the radiation at the top of the atmosphere reaches the earth's surface on clear days. Some studies (3) have shown that the middle curve can be computed in the same manner as the top curve, only using a value of 1.60 instead of the solar constant of 1.94 gram calories per square centimeter per minute. The studies show that at State College, a constant of 1.56 would be needed.

ESTIMATION OF SOLAR RADIATION

Estimation by Evaporation. This study shows that the evaporation of water is the best single parameter for use in estimating solar radiation. Figure 3 presents curves for pan evaporation and solar radiation based on monthly averages. Figure 4 shows a plot of weekly values of pan evaporation and solar radiation which were used to obtain the following relationship:

$$Rs = 1674.052Ep+133.8335 \qquad [2]$$

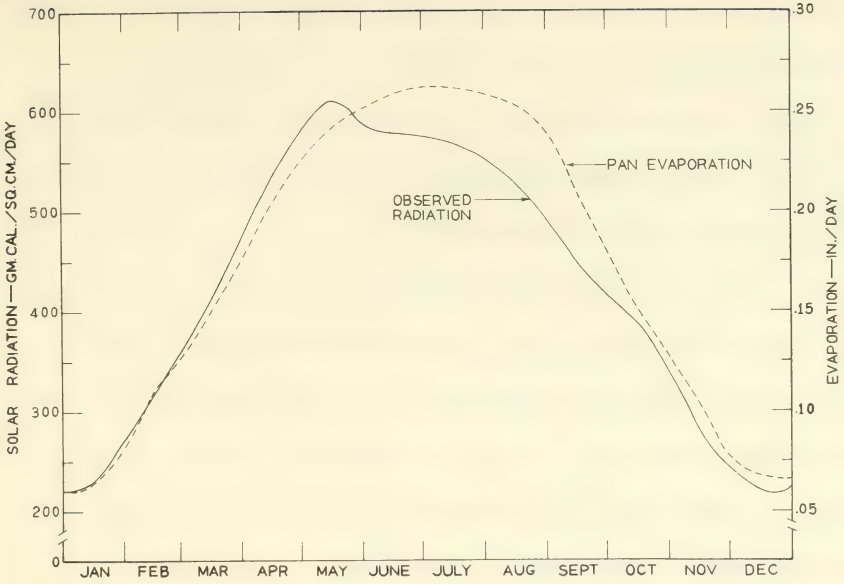

Figure 3 - Solar Radiation and Pan Evaporation

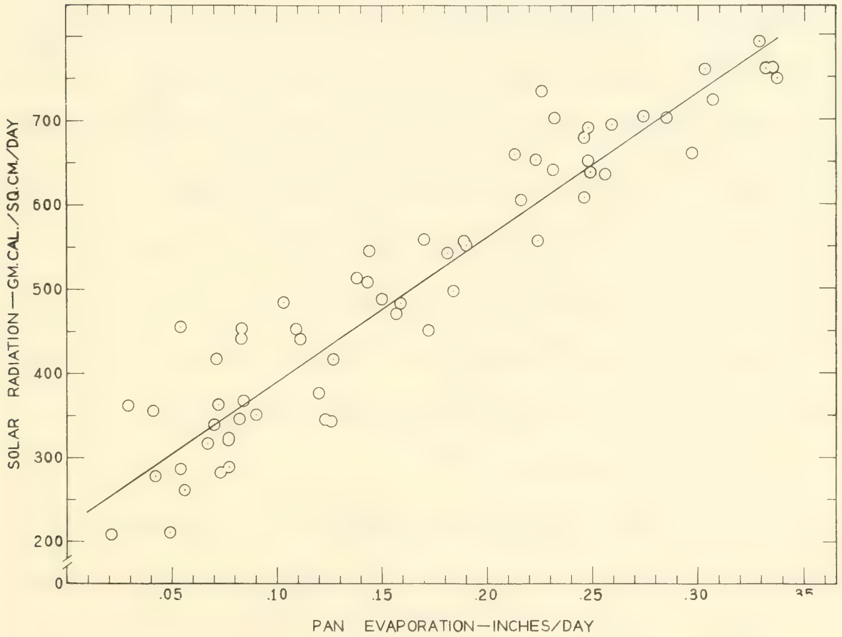

Figure 4 - Relationship of Solar Radiation to Pan Evaporation

where Rs is daily solar radiation in gram calories per square centimeter and Ep is daily pan evaporation in inches.

Since wind movement can affect evaporation, and thus affect the estimation of solar radiation by evaporation, we can add wind movement as a variable and obtain the equation:

$$Rs = 1670Ep - .06725W + 137.352 \qquad [3]$$

The above equations are perhaps the most significant estimates of solar radiation with one or two parameters whose data are available to most weather observers. It might be added that since evaporation from a free water surface is estimated to be 0.7 times that from a Weather Bureau pan (6), equation [2] becomes:

$$Rs = 2391.503Eo + 133.8335 \qquad [4]$$

where Eo is evaporation from a free water surface.

Estimation by Air Temperature. Since it takes time for the sun's rays to heat the earth's atmosphere, it seems logical that there would be a lag in the effect of solar radiation on air temperature. Curves for these variables based on monthly averages are presented in Figure 5. In this study, solar radiation for one month was correlated with the air temperature for the next month to allow for temperature lag. It was found that solar radiation for a month can give a very good prediction of the temperature for the next month. The relationship shown in Figure 6 is expressed as follows:

$$Ta = .096089Rs + 21.970 \qquad [5]$$

where Ta is the average daily air temperature for the month in degrees Fahrenheit and Rs is the average daily solar radiation for the preceding

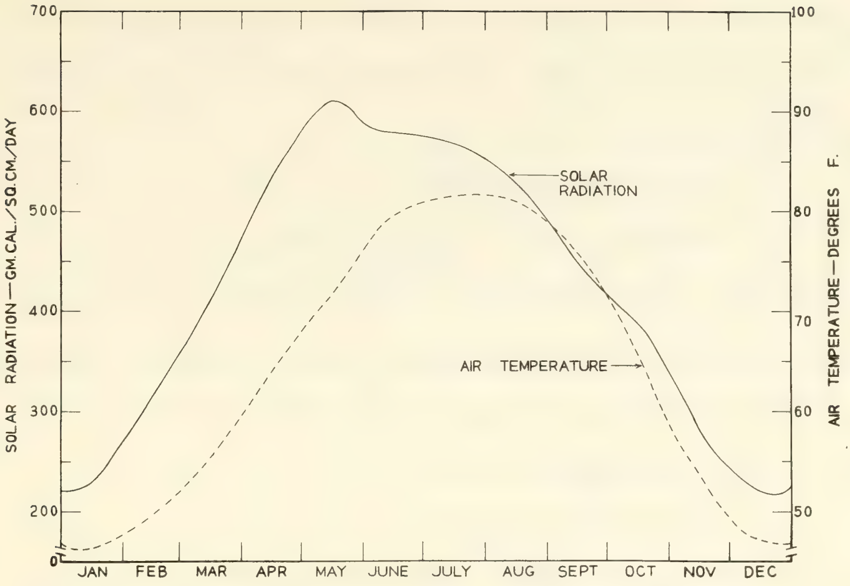

Figure 5 - Solar Radiation and Air Temperature

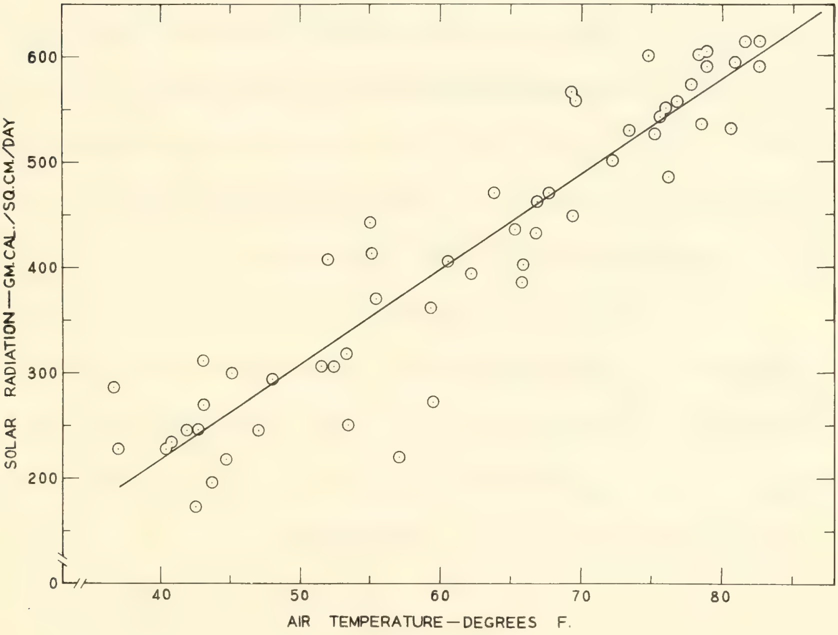

Figure 6 - Relationship of Solar Radiation for a Month to Air Temperature of the Following Month

month in gram calories per square centimeter. If it is desired to estimate solar radiation from the air temperature of the following month, the equation becomes:

$$Rs=9.00177Ta-141.504 \qquad [6]$$

Solar radiation can also be estimated from air temperature on a weekly basis. Closer correlation is obtained using the average of the daily maximum temperatures rather than the mean temperature for the week. When this average of the daily maximum temperatures, Tah is used, the following relation is obtained:

$$Rs=7.4077Tah-125.739 \qquad [7]$$

If it is desired to use the weekly mean temperature, Ta, in making the solar radiation estimate, the following equation may be used:

$$Rs=7.3314Ta-41.399 \qquad [8]$$

Many of the cooperative weather stations throughout the country have facilities for measuring pan evaporation, wind movement, and air temperature. If information on all these parameters is available, solar radiation can be estimated more accurately by using the following equation:

$$\begin{aligned} Rs=1972.548Ep-.6059W+14.2500Tah \\ +4.6900Tal-21.5700Ta+170.649 \qquad [9] \end{aligned}$$

Estimation by Soil Temperature. Since soil tends to absorb solar radiation more readily than the air, the use of soil temperatures, especially those close to the surface, is a better means of estimating solar radiation than is the use of air temperature.

Soil temperatures at State College, Mississippi, are obtained from depths of 2, 4, 8, and 16 inches. The measurements are made with temperature recorders whose sensing elements are located under bare clay soil which is classified as Angie fine sandy loam. The site is approximately an 8 percent slope and slopes to the south.

It was observed through examination of the soil temperature charts that the daily rise in soil temperature from morning to evening seems to vary in accordance with the intensity of solar radiation received on a horizontal surface. Hence, the weekly average of the daily difference between maximum and minimum soil temperatures as well as the weekly average of the daily maximum, minimum, and mean soil temperatures was compared with solar radiation.

The best single soil temperature estimate of solar radiation in this study was the daily rise in soil temperature at the two-inch depth. Curves depicting monthly averages of these variables are shown in Figure 7; while, Figure 8 shows the relationship between the weekly values of these two variables which is expressed by:

$$Rs = 22.3219T2d+39.3818 \qquad [10]$$

If the weekly value of the daily maximum values is added to [10], the equation becomes:

$$Rs = 2.5534T2h+15.2401T2d-31.3523 \qquad [11]$$

At the four-inch depth, the daily maximum temperature proved to be a better estimate of solar radiation than the daily rise in temperature. The equation for estimating solar radiation from the four-inch daily maximum soil temperature is:

$$Rs = 6.6550T4h-61.394 \qquad [12]$$

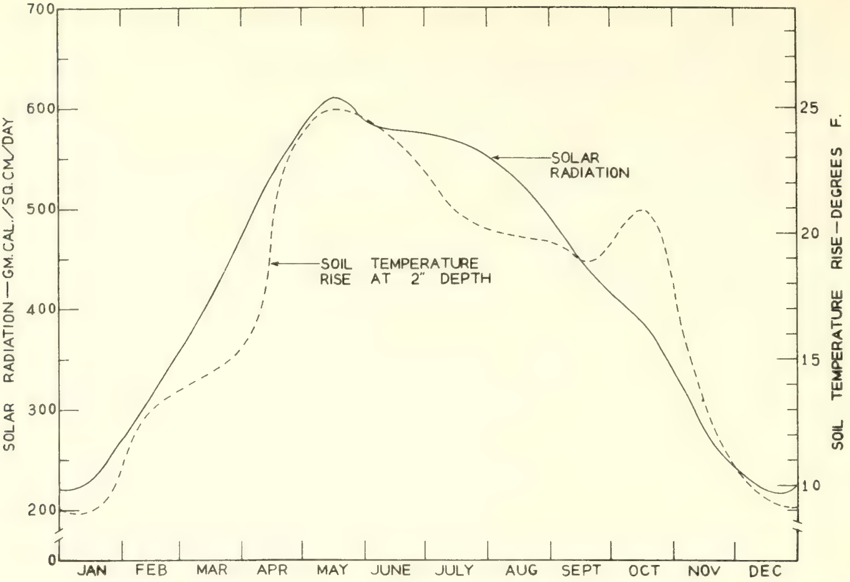

Figure 7 - Solar Radiation and the Daily Rise in 2" Soil Temperature

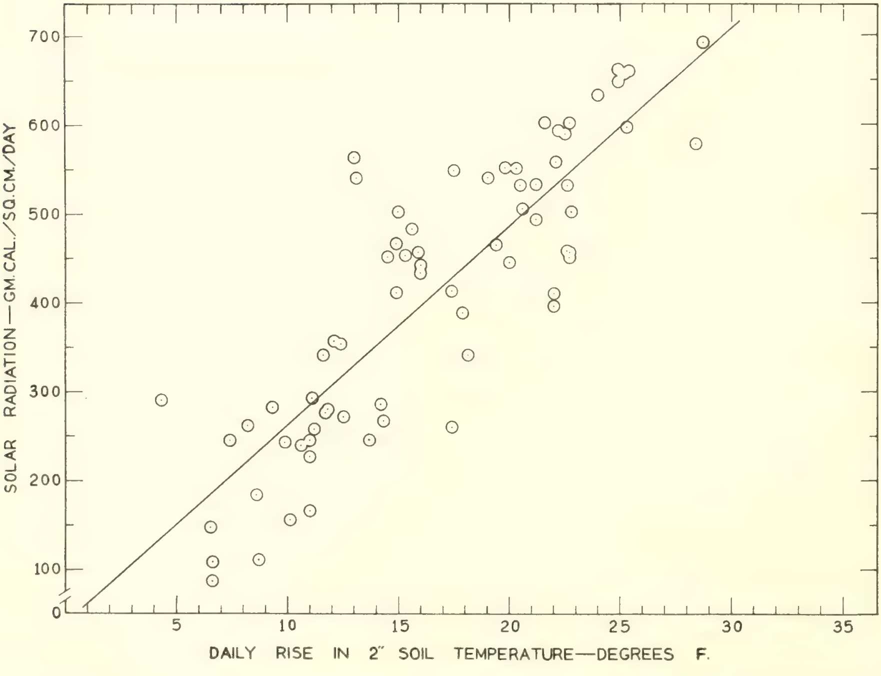

Figure 8 - Relationship of Solar Radiation to the Daily Rise in 2 inch Soil Temperature

If the daily rise in temperature is added to the equation, it becomes:

$$Rs=4.2326T4h+10.8788T4d-25.227 \qquad [13]$$

The daily rise in temperature at the eight-inch depth proved to be the most significant estimate of solar radiation at that depth, and the equation for estimating solar radiation using this parameter is:

$$Rs=59.8786T8d+45.246 \qquad [14]$$

When the daily maximum temperature at that depth is considered with the daily rise at that depth, the equation becomes:

$$Rs=3.7643T8h+39.0603T8d-82.2636 \qquad [15]$$

The values of soil temperatures at the 16-inch depth do not make very good estimates of solar radiation. The daily rise in temperature at this depth is so slight that it is of no value in determining solar radiation. Using the daily maximum temperature at this depth, the following equation is obtained:

$$Rs=8.0830T16h-119.4475 \qquad [16]$$

When the soil temperature values are considered with the air temperature, evaporation, and wind movement values discussed earlier, solar radiation can be estimated very accurately using the following equation:

$$\begin{aligned}Rs=&2655.106Ep-1.3266W-221.163Tah-216.626Tal\\&+446.781Ta+25.224T4h-43.739T4l+.9243T8d\\&-12.708T2d-57.607T16d+601.453 \qquad [17]\end{aligned}$$

ESTIMATION OF SOIL TEMPERATURES

Soil temperatures at each of the four depths used in this study can be accurately computed by using the mean air temperature. All the equations presented below are based on weekly values:

$$T2h=1.1962Ta+.27389 \qquad [18]$$

$$T2l=.0960Ta+1.4404 \qquad [19]$$

$$T2=1.0511Ta+.8608 \qquad [20]$$

$$T4h=1.1493Ta+1.1452 \qquad [21]$$

$$T4l=.9126Ta+2.9961 \qquad [22]$$

$$T4=1.0310Ta+2.0672 \qquad [23]$$

$$T8h=.9655Ta+8.3121 \qquad [24]$$

$$T8l=.8700Ta+7.9217 \qquad [25]$$

$$T8=.9175Ta+8.1314 \qquad [26]$$

$$T16h=.8409Ta+13.988 \qquad [27]$$

$$T16l=.8341Ta+13.029 \qquad [28]$$

$$T16=.8370Ta+13.537 \qquad [29]$$

All of these equations are very significant statistically and can be used to estimate weekly soil temperatures accurately. Figures 9 and 10 show one of these relationships and give a picture of the accuracy of the equation.

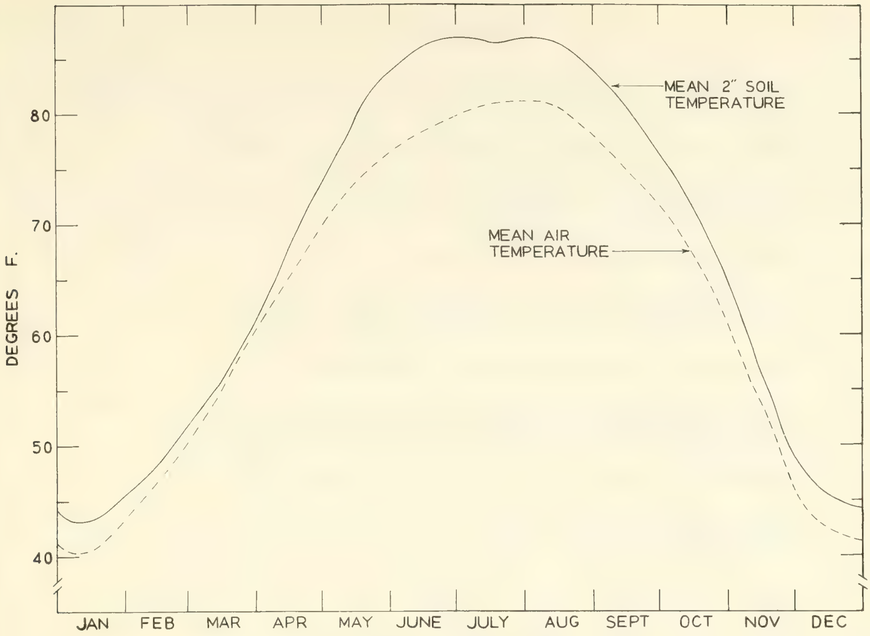

Figure 9 - Mean Air Temperature and Mean 2 inch Soil Temperature

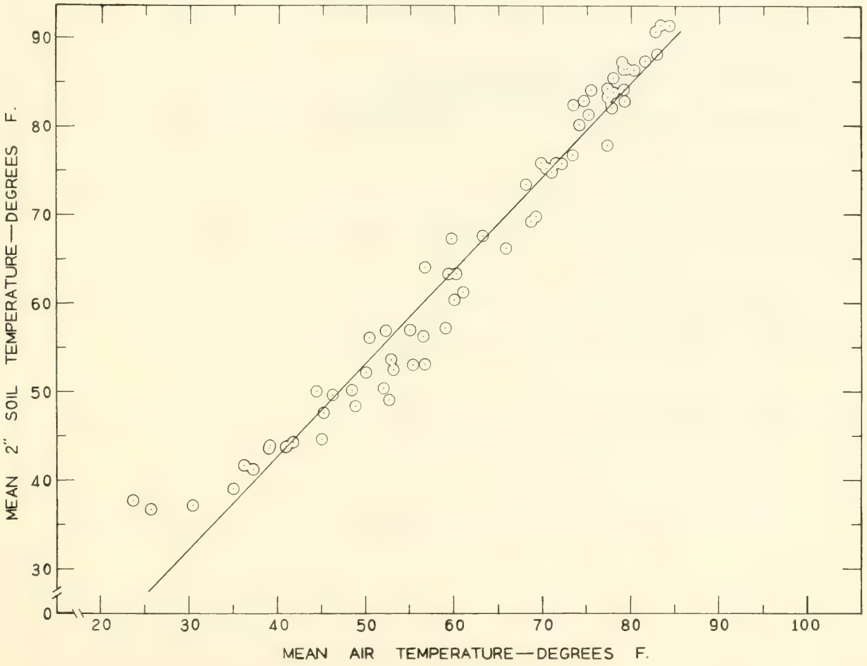

Figure 10 - Relationship of Air Temperature to 2 inch Soil Temperature

SYMBOLS

Rs = Daily solar radiation in gram calories per square centimeter

Rsx = Daily solar radiation at the top of the atmosphere

Rsc = Daily clear-sky radiation

Ep = Daily pan evaporation in inches

Eo = Daily evaporation from a free water surface

Ta = Mean daily air temperature in degrees F.

Tah = Maximum daily air temperature in degrees F.

Tal = Minimum daily air temperature in degrees F.

W = Daily wind movement in miles

T2 = Mean daily 2-inch soil temperature

T2h = Maximum daily 2-inch soil temperature

T2l =Minimum daily soil temperature at 2-inch depth

T2d = Daily rise in 2-inch soil temperature

T4 =Mean daily 4-inch soil temperature

T4h = Maximum daily 4-inch soil temperature

T4l = Minimum daily 4-inch soil temperature

T4d = Daily rise in 4-inch soil temperature

T8 = Mean daily 8-inch soil temperature

T8h = Maximum daily 8-inch soil temperature

T8l = Minimum daily 8-inch soil temperature

T8d = Daily rise in 8-inch soil temperature

T16 = Mean daily 16-inch soil temperature

T16h = Maximum daily 16-inch soil temperature

T16l = Minimum daily 16-inch soil temperature

T16d = Daily rise in 16-inch soil temperature

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TABLE 1 - STATISTICAL SIGNIFICANCE

Equation	No. of Observations	No. of Independent Variables	R^2	F
1	59	1	.960	1357
2	241	1	.850	1352
3	241	2	.851	679.
4	241	1	.850	1352
5	56	1	.865	346.
6	56	1	.865	346.
7	241	1	.591	346.
8	241	1	.549	291.
9	241	5	.880	343.
10	134	1	.752	401.
11	134	2	.780	233.
12	205	1	.613	321.
13	205	2	.648	186.
14	205	1	.644	367.
15	205	2	.704	240.
16	134	1	.537	153.
17	134	10	.940	191.
18	134	1	.952	2590
19	134	1	.960	3159
20	134	1	.966	3757
21	205	1	.945	3473
22	205	1	.952	4049
23	205	1	.956	4439
24	205	1	.948	3717
25	205	1	.945	3519
26	205	1	.949	3798
27	134	1	.910	1332
28	134	1	.906	1268
29	134	1	.907	1294

TABLE 2 - DAILY AVERAGES OF WEATHER DATA FOR MONTHS

onth	Solar Radiation Gm. Cal./ Sq. Cm./day	Air Temperature - Degrees F. Max.	Min.	Mean	Pan Evap. In./Day	Wind Movement Mi./Day	Rainfall Inches/Mo.
an.	228.5	56.8	36.1	46.4	.069	70.3	5.15
eb.	312.0	60.6	38.5	49.5	.108	75.1	4.93
ar.	410.3	66.9	44.1	55.5	.149	76.4	6.16
pr.	530.5	75.6	51.9	63.8	.203	64.2	4.56
ay	610.4	83.3	60.0	71.7	.242	44.7	4.04
une	579.1	90.5	67.6	79.1	.258	36.4	3.96
uly	568.5	92.5	70.3	81.4	.262	32.8	4.74
ug.	527.1	92.3	69.5	80.9	.254	30.3	3.53
ept.	451.6	88.1	64.2	76.1	.211	36.1	2.68
ct.	388.4	78.3	53.2	65.7	.152	37.4	2.51
ov.	282.1	65.7	42.3	54.0	.105	56.8	3.61
ec.	220.1	57.5	37.0	47.3	.068	62.9	4.96

TABLE 3 - MONTHLY SOIL TEMPERATURE AVERAGES IN DEGREES F.

	2-inch depth			4-inch depth			8-inch depth			16-inch depth		
nth	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
n.	47.8	38.8	43.3	47.3	40.5	43.9	47.1	43.1	45.1	46.8	45.5	46.1
b.	54.6	41.6	48.1	53.4	45.0	49.2	51.8	47.0	49.4	49.4	48.3	48.8
r.	63.0	48.5	55.8	62.6	52.2	57.4	59.1	53.3	56.2	55.5	54.1	54.8
r.	77.6	58.0	67.8	73.5	59.1	66.3	67.7	60.6	64.2	65.2	63.5	64.3
y	92.2	67.3	79.8	84.8	68.2	76.5	78.4	70.1	74.2	75.2	73.3	74.2
ne	97.8	74.0	85.9	91.8	75.5	83.6	84.7	76.5	80.6	80.9	79.3	80.1
ly	96.0	75.8	85.9	93.5	78.0	85.7	86.4	79.0	82.7	83.1	81.7	82.4
g.	96.4	76.3	86.3	95.6	78.2	86.9	87.5	79.8	83.6	83.7	82.2	82.9
pt.	90.4	71.4	80.9	90.1	73.7	81.9	83.2	76.0	79.6	80.2	78.8	79.5
t.	82.1	61.2	71.6	79.7	64.0	71.9	74.8	67.2	71.0	72.6	71.2	71.9
v.	63.5	49.9	56.7	63.3	52.4	57.8	61.1	55.9	58.5	61.7	60.4	61.0
c.	50.0	40.5	45.3	50.2	42.6	46.4	50.1	46.2	48.2	50.8	49.5	50.2

TABLE 4 - DAILY AVERAGES FOR WEEKS OF SOLAR RADIATION, WIND, EVAPORATION, AND AIR TEMPERATURES

Middle of Week	Solar Radiation gm. cal./ sq. cm. Rs	Pan Evap. Inches Ep	Wind Movement Miles W	Air Temperature - Degrees F.		
				Max. Tah	Min. Tal	Mean Ta
July 29, '59	603.5	.274	33.1	93.1	72.7	82.9
Aug. 5	535.2	.291	38.7	94.4	71.6	83.0
Aug. 12	528.2	.230	32.9	90.7	67.1	78.9
Aug. 19	507.8	.246	29.9	92.1	66.9	79.5
Aug. 26	500.6	.243	34.7	93.0	69.9	81.4
Sep. 2	547.1	.233	36.3	91.4	68.3	79.8
Sep. 9	372.0	.193	35.6	87.4	66.1	76.8
Sep. 16	384.5	.103	47.0	78.0	62.3	70.2
Sep. 23	468.3	.217	44.3	86.0	63.0	74.5
Sep. 30	451.9	.183	26.9	88.4	66.6	77.5
Oct. 7	313.9	.116	26.3	84.6	67.4	76.0
Oct. 14	263.1	.072	39.9	74.1	55.9	65.0
Oct. 21	324.0	.120	61.6	72.7	54.9	63.8
Oct. 28	228.5	.078	64.1	67.3	49.4	58.4
Nov. 4	346.0	.124	62.6	74.0	49.1	61.6
Nov. 11	250.6	.090	35.6	67.3	39.0	53.2
Nov. 18	291.8	.070	32.7	57.1	32.3	44.7
Nov. 25	283.2	.110	73.7	67.4	43.0	55.2
Dec. 2	291.1	.069	41.4	54.3	32.4	43.4
Dec. 9	220.8	.077	68.3	60.6	40.1	50.4
Dec. 16	177.8	.054	59.6	56.9	40.9	48.9
Dec. 23	153.8	.050	45.4	54.9	35.4	45.2
Dec. 30	196.1	.160	87.7	54.4	39.3	46.8
Jan. 6, '60	178.1	.042	51.1	47.6	33.1	40.4
Jan. 13	173.7	.064	60.9	67.4	52.3	59.8
Jan. 20	272.5	.064	76.3	41.4	26.0	33.7
Jan. 27	218.0	.073	60.1	56.1	35.6	45.8
Feb. 3	182.4	.073	93.9	55.7	41.7	48.7
Feb. 10	300.5	.126	97.0	58.9	38.1	48.5
Feb. 17	376.2	.067	54.4	46.6	26.1	36.4
Feb. 24	307.3	.080	63.1	50.6	31.9	41.2
Mar. 2	317.0	.071	85.3	43.3	27.7	35.5
Mar. 9	360.9	.095	59.9	49.1	31.1	40.1
Mar. 16	373.6	.154	82.0	52.0	33.7	42.8
Mar. 23	524.8	.157	56.4	63.9	34.3	49.1
Mar. 30	370.5	.157	58.4	74.1	53.0	63.6
Apr. 6	500.4	.216	57.4	73.9	49.9	61.9
Apr. 13	615.8	.207	46.4	76.1	48.7	62.4
Apr. 20	568.8	.207	44.1	81.1	54.0	67.6
Apr. 27	552.7	.223	36.4	81.7	59.1	70.4
May 4	483.6	.220	59.6	76.4	52.7	64.6
May 11	624.1	.226	55.6	71.4	46.3	58.9
May 18	619.1	.260	45.6	86.6	64.9	75.7
May 25	659.1	.303	47.0	88.7	63.9	76.3
June 1	563.9	.237	29.0	86.6	64.7	75.6
June 8	706.7	.304	26.3	89.7	66.1	77.9
June 15	648.3	.294	53.1	88.0	65.1	76.6
June 22	622.0	.307	42.1	94.3	70.1	82.2
June 29	582.7	.309	46.7	93.4	72.4	82.9
July 6	557.1	.289	38.1	92.3	68.4	80.4
July 13	649.3	.324	38.1	95.9	70.1	83.0
July 20	559.9	.297	22.4	96.7	69.9	83.3
July 27	568.9	.279	28.1	95.6	70.1	82.9
Aug. 3	573.7	.286	39.3	96.1	71.7	83.9
Aug. 10	432.9	.221	34.7	91.4	70.9	81.1

TABLE 4 CONTINUED

Middle of Week	Solar Radiation gm. cal./ sq. cm. Rs	Pan Evap. Inches Ep	Wind Movement Miles W	Air Temperature - Degrees F.		
				Max. Tah	Min. Tal	Mean Ta
Aug. 17, '60	458.0	.170	23.9	89.6	70.4	80.0
Aug. 24	483.0	.241	30.6	87.9	69.4	78.6
Aug. 31	543.6	.241	22.1	92.9	68.7	80.8
Sep. 7	466.9	.244	27.7	93.9	71.7	82.8
Sep. 14	387.6	.150	50.9	81.0	60.9	70.9
Sep. 21	498.1	.229	24.9	90.4	65.0	77.7
Sep. 28	321.9	.124	38.1	80.3	61.4	70.9
Oct. 5	311.0	.168	27.1	83.3	63.9	73.6
Oct. 12	407.9	.143	12.7	81.0	58.7	69.9
Oct. 19	403.0	.134	24.9	74.3	50.3	62.3
Oct. 26	373.1	.130	22.4	75.9	49.4	62.6
Nov. 2	337.7	.143	63.6	71.3	46.0	58.6
Nov. 9	352.6	.109	54.4	60.9	36.0	48.4
Nov. 16	303.3	.113	31.0	72.4	47.7	60.1
Nov. 23	232.0	.067	17.1	65.6	45.6	55.6
Nov. 30	341.0	.101	50.7	60.4	35.7	48.1
Dec. 7	189.0	.077	50.0	60.3	40.7	50.5
Dec. 14	245.3	.056	63.6	45.4	28.1	36.8
Dec. 21	276.1	.073	51.7	53.0	26.1	39.6
Dec. 28	168.9	.048	43.0	55.9	38.4	47.2
Jan. 4, '61	186.6	.054	36.3	52.1	32.1	42.1
Jan. 11	240.6	.051	38.0	56.0	34.0	45.0
Jan. 18	296.6	.074	79.1	56.4	33.1	44.8
Jan. 25	210.6	.051	54.9	41.6	24.6	33.1
Feb. 1	355.0	.054	33.3	54.3	28.7	41.5
Feb. 8	242.4	.053	75.6	53.9	33.6	43.7
Feb. 15	329.9	.133	64.6	75.9	51.9	63.9
Feb. 22	218.4	.112	79.1	67.3	46.1	56.7
Mar. 1	340.9	.111	58.6	67.3	44.0	55.6
Mar. 8	395.9	.125	86.4	71.4	50.7	61.0
Mar. 15	430.0	.203	92.9	74.1	48.1	61.1
Mar. 22	505.3	.157	54.0	66.3	44.0	55.1
Mar. 29	350.0	.172	60.0	70.7	50.6	60.6
Apr. 5	482.3	.176	69.7	68.0	42.1	55.1
Apr. 12	461.1	.186	93.7	68.7	46.0	57.4
Apr. 19	696.6	.270	76.7	74.7	47.7	61.2
Apr. 26	590.0	.248	53.1	80.0	57.9	68.9
May 3	569.7	.227	35.7	79.1	54.7	66.9
May 10	564.6	.213	40.3	79.4	56.0	67.7
May 17	646.0	.264	41.9	84.4	60.9	72.5
May 24	559.4	.213	44.3	80.7	58.0	69.4
May 31	716.7	.300	27.1	86.6	59.3	72.9
June 7	518.3	.232	33.6	88.4	67.4	77.9
June 14	450.6	.191	34.3	83.3	66.3	74.8
June 21	444.7	.144	35.0	79.1	61.7	70.4
June 28	621.3	.241	19.0	85.7	64.6	75.1
July 5	553.9	.229	30.9	87.0	66.4	76.7
July 12	430.9	.172	37.3	83.7	66.4	75.1
July 19	538.3	.249	29.6	89.6	69.3	79.4
July 26	598.3	.210	23.6	90.1	68.7	79.4
Aug. 2	618.1	.273	29.1	91.7	71.1	81.4
Aug. 9	535.4	.256	20.4	89.6	68.1	78.9
Aug. 16	500.9	.256	31.9	87.0	67.7	77.4
Aug. 23	540.4	.220	22.4	85.3	64.1	74.7
Aug. 30	507.7	.243	20.0	92.4	70.9	81.6
Sep. 6	451.1	.190	27.4	89.3	69.3	79.3
Sep. 13	401.9	.167	50.6	82.0	63.1	72.6
Sep. 20	531.7	.197	20.6	84.1	59.3	71.7

TABLE 4 CONTINUED

Middle of Week	Solar Radiation gm. cal./ sq. cm. Rs	Pan Evap. Inches Ep	Wind Movement Miles W	Air Temperature - Degrees F.		
				Max. Tah	Min. Tal	Mean Ta
Sep. 27, '61	497.0	.223	17.7	89.1	63.7	76.4
Oct. 4	413.6	.138	33.9	75.3	51.0	63.2
Oct. 11	427.7	.182	20.7	81.9	57.7	69.8
Oct. 18	459.4	.156	14.6	73.7	45.6	59.6
Oct. 25	402.6	.150	22.0	74.9	44.7	59.8
Nov. 1	245.1	.123	47.0	79.4	59.1	69.2
Nov. 8	314.7	.109	26.4	61.9	40.3	51.1
Nov. 15	147.9	.118	55.4	66.7	53.3	60.0
Nov. 22	278.6	.092	34.1	60.9	40.7	50.8
Nov. 29	267.7	.084	21.0	62.9	41.0	52.0
Dec. 6	167.3	.082	41.7	64.1	45.1	54.6
Dec. 13	87.0	.100	31.1	52.0	40.3	46.2
Dec. 20	199.7	.064	42.6	56.3	39.7	48.0
Dec. 27	239.6	.070	28.7	46.7	26.6	36.6
Jan. 3, '62	161.9	.056	52.1	55.9	35.9	45.9
Jan. 10	290.7	.049	37.0	35.1	12.3	23.7
Jan. 17	192.6	.049	35.3	48.0	31.6	39.8
Jan. 24	111.1	.049	26.1	66.7	46.7	56.7
Jan. 31	402.0	.113	35.3	68.0	39.1	53.6
Feb. 7	272.0	.086	59.7	58.4	38.3	48.4
Feb. 14	384.1	.156	58.6	71.4	46.7	59.0
Feb. 21	276.1	.120	53.6	70.4	47.7	59.0
Feb. 28	179.3	.087	64.7	63.7	44.3	54.0
Mar. 7	293.1	.078	62.3	54.9	35.6	45.2
Mar. 14	481.0	.137	57.6	58.6	37.6	48.1
Mar. 21	442.6	.181	37.6	68.0	45.0	56.5
Mar. 28	472.1	.229	59.1	74.0	48.3	61.2
Apr. 4	466.1	.148	49.1	62.3	41.9	52.1
Apr. 11	570.9	.213	61.3	75.3	51.1	63.2
Apr. 18	633.1	.226	52.1	73.4	46.9	60.2
Apr. 25	546.6	.229	52.6	80.0	58.3	69.2
May 2	656.3	.239	38.9	82.9	59.1	71.0
May 9	688.9	.271	33.4	87.9	62.9	75.4
May 16	691.1	.329	22.3	91.4	67.1	79.2
May 23	641.0	.307	39.1	91.0	69.3	80.2
May 30	533.0	.290	37.4	89.6	65.9	77.8
June 6	580.4	.234	27.0	86.7	66.1	76.4
June 13	601.4	.232	19.3	85.0	66.0	75.5
June 20	664.3	.287	19.0	91.9	70.0	81.0
June 27	596.9	.273	24.0	89.1	69.0	79.0
July 4	672.1	.360	30.6	94.0	71.6	82.8
July 11	648.6	.337	25.6	94.6	72.1	83.4
July 18	645.0	.328	26.3	95.9	71.4	83.6
July 25	493.7	.265	21.6	91.4	71.7	81.6
Aug. 1	507.3	.226	14.7	89.7	71.0	80.4
Aug. 8	660.4	.335	31.1	94.0	71.6	82.8
Aug. 15	605.6	.335	23.4	95.3	69.4	82.4
Aug. 22	464.9	.219	23.7	90.9	70.0	80.4
Aug. 29	493.9	.249	15.4	94.0	70.9	82.4
Sep. 5	455.9	.224	26.3	89.6	68.7	79.2
Sep. 12	418.6	.190	14.3	91.6	71.7	81.6
Sep. 19	531.4	.250	26.6	85.1	61.9	73.5
Sep. 26	483.0	.202	17.4	80.1	56.9	68.5
Oct. 3	451.3	.195	13.4	82.6	58.3	70.4
Oct. 10	382.9	.159	16.0	85.1	64.6	74.8
Oct. 17	410.3	.174	17.1	84.1	60.3	72.2

TABLE 4 CONTINUED

Middle of Week	Solar Radiation gm. cal./ sq. cm. Rs	Pan Evap. Inches Ep	Wind Movement Miles W	Air Temperature - Degrees F.		
				Max. Tah	Min. Tal	Mean Ta
Oct. 24, '62	414.6	.154	27.3	68.1	45.6	56.8
Oct. 31	341.4	.127	20.7	66.9	46.4	56.6
Nov. 7	358.0	.133	48.9	60.7	38.1	49.4
Nov. 14	260.0	.110	47.9	65.7	45.3	55.0
Nov. 21	215.7	.083	38.6	59.9	42.9	51.4
Nov. 28	228.3	.077	29.3	61.7	44.0	52.8
Dec. 5	277.9	.096	46.0	59.4	37.9	48.6
Dec. 12	283.7	.057	57.4	40.7	19.9	30.3
Dec. 19	201.1	.045	19.4	62.0	40.6	51.3
Dec. 26	109.1	.021	41.3	46.7	33.3	40.0
Jan. 2, '63	258.4	.054	17.0	55.9	32.4	44.2
Jan. 9	155.3	.047	60.0	56.3	41.4	48.8
Jan. 16	226.0	.023	35.6	42.7	23.9	33.3
Jan. 23	261.4	.029	68.4	36.1	15.0	25.6
Jan. 30	234.3	.043	66.6	50.0	26.6	38.3
Feb. 6	356.9	.112	40.9	52.4	31.0	41.7
Feb. 13	387.0	.098	77.4	47.9	27.1	37.5
Feb. 20	340.9	.083	60.0	48.0	26.4	37.2
Feb. 27	420.9	.127	73.1	57.7	30.9	44.3
Mar. 6	433.6	.187	84.9	67.6	43.0	55.3
Mar. 13	357.3	.137	77.4	71.7	46.6	59.2
Mar. 20	540.1	.231	58.9	72.1	50.0	61.0
Mar. 27	575.3	.249	44.6	77.0	51.7	64.3
Apr. 3	483.1	.218	48.3	75.9	55.6	65.8
Apr. 10	590.4	.234	35.4	77.1	53.1	65.1
Apr. 17	579.0	.246	47.4	80.9	58.7	69.8
Apr. 24	367.0	.162	43.9	72.7	57.3	65.0
May 1	589.9	.230	46.7	76.4	61.0	68.7
May 8	668.9	.306	33.1	86.9	64.1	75.5
May 15	601.6	.285	43.4	87.4	68.7	78.0
May 22	587.7	.239	33.9	80.7	57.7	69.2
May 29	550.3	.256	36.6	83.3	63.6	73.4
June 5	699.1	.297	16.4	89.7	66.0	77.8
June 12	660.1	.332	22.6	95.4	73.4	84.4
June 19	411.6	.214	25.6	83.0	69.6	76.3
June 26	548.7	.214	20.7	83.6	66.7	75.2
July 3	671.6	.293	23.9	90.9	71.3	81.1
July 10	594.1	.259	31.4	87.0	67.7	77.4
July 17	425.1	.251	29.3	87.0	70.0	78.5
July 24	453.1	.213	20.9	86.1	69.7	77.9
July 31	509.3	.235	17.1	91.3	72.0	81.6
Aug. 7	550.6	.248	15.9	93.0	73.0	83.0
Aug. 14	533.9	.224	30.7	86.6	68.1	77.4
Aug. 21	558.6	.238	17.9	89.9	69.1	79.5
Aug. 28	494.4	.245	23.9	91.3	71.4	81.4
Sep. 4	504.9	.216	16.0	88.9	67.1	78.0
Sep. 11	459.3	.208	24.4	87.7	66.0	76.8
Sep. 18	445.1	.198	27.4	84.3	64.0	74.2
Sep. 25	401.6	.186	49.0	76.6	58.0	67.3
Oct. 2	456.4	.189	25.0	80.4	55.6	68.0
Oct. 9	488.7	.224	18.4	85.6	56.6	71.1
Oct. 16	451.0	.207	23.1	86.1	56.9	71.5
Oct. 23	344.4	.142	11.9	83.0	56.7	69.8
Oct. 30	397.1	.184	37.7	70.9	47.6	59.3
Nov. 6	271.3	.097	28.6	66.9	44.4	55.6
Nov. 13	389.6	.146	40.4	63.1	37.7	50.4
Nov. 20	220.1	.106	50.1	72.4	54.1	63.2

TABLE 4 CONTINUED

Middle of Week	Solar Radiation gm. cal./ sq. cm.	Pan Evap. Inches	Wind Movement Miles	Air Temperature Degrees F.		
				Max.	Min.	Mean
Nov. 27, '63	245.6	.082	52.9	59.0	40.9	50.0
Dec. 4	285.9	.103	43.1	58.0	33.0	45.5
Dec. 11	184.3	.024	58.9	45.0	33.1	39.0
Dec. 18	240.1	.032	34.9	36.1	17.7	26.9
Dec. 25	245.4	.041	31.3	44.4	25.6	35.0
Jan. 1, '64	253.0	.070	59.6	48.0	29.3	38.6
Jan. 8	165.9	.034	51.9	50.1	31.7	40.9
Jan. 15	262.9	.043	55.9	41.9	21.6	31.8
Jan. 22	243.9	.126	75.4	63.3	41.9	52.6
Jan. 29	335.7	.095	45.3	56.7	33.7	45.2
Feb. 5	258.9	.085	69.1	54.0	35.9	45.0
Feb. 12	328.4	.111	87.0	54.3	30.9	42.6
Feb. 19	354.1	.083	51.3	46.7	31.3	39.0
Feb. 26	331.7	.106	65.4	52.0	32.1	42.0
Mar. 4	280.0	.164	101.3	63.9	42.3	53.1

TABLE 5 - DAILY AVERAGES FOR WEEKS OF 4 AND 8 INCH SOIL TEMPERATURES

Middle of Week	4-inch Soil Temp. - Degrees F. Max. T4h	Min. T4l	Mean T4	Rise T4d	8-inch Soil Temp. - Degrees F. Max. T8h	Min. T8l	Mean T8	Rise T8d
Apr. 6, '60	65.6	54.3	59.9	11.3	61.4	56.7	59.1	4.7
Apr. 13	70.7	54.7	62.7	16.0	65.1	57.3	61.2	7.8
Apr. 20	74.9	60.0	67.4	14.9	67.8	62.1	65.0	5.7
Apr. 27	80.0	65.0	72.5	15.0	72.8	66.0	69.4	6.8
May 4	74.1	62.4	68.3	11.7	69.4	64.7	67.1	4.7
May 11	71.0	57.6	64.3	13.4	66.6	60.7	63.6	5.9
May 18	80.1	68.6	74.4	11.5	74.9	69.3	72.1	5.6
May 25	82.1	70.6	76.4	11.5	76.9	72.0	74.4	4.9
June 1	83.0	70.1	76.6	12.9	77.6	71.4	74.5	6.2
June 8	93.9	74.6	84.2	19.3	85.7	76.3	81.0	9.4
June 15	90.1	73.3	81.7	16.8	83.3	75.7	79.5	7.6
June 22	94.0	75.6	84.8	18.4	85.8	77.0	81.4	8.8
June 29	94.3	77.9	86.1	16.4	86.6	79.4	83.0	7.2
July 6	92.6	76.4	84.5	16.2	85.7	78.1	81.9	7.6
July 13	97.3	79.6	88.4	17.7	89.3	81.4	85.4	7.9
July 20	98.1	80.0	89.1	18.1	89.7	81.9	85.8	7.8
July 27	96.7	77.9	87.3	18.8	88.9	80.1	84.5	8.8
Aug. 3	100.7	80.4	90.6	20.3	91.0	82.3	86.6	8.7
Aug. 10	91.7	77.4	84.6	14.3	85.9	79.3	82.6	6.6
Aug. 17	91.4	76.1	83.8	15.3	85.3	78.4	81.9	6.9
Aug. 24	90.9	75.4	83.1	15.5	85.1	78.0	81.6	7.1
Aug. 31	98.0	77.6	87.8	20.4	89.0	80.3	84.6	8.7
Sep. 7	96.4	79.1	87.8	17.3	89.3	81.4	85.4	7.9
Sep. 14	83.6	68.4	76.0	15.2	79.3	72.0	75.6	7.3
Sep. 21	94.1	73.3	83.7	20.8	85.1	76.3	80.7	8.8
Sep. 28	85.1	67.9	76.5	17.2	78.4	71.4	74.9	7.0
Oct. 5	83.3	68.7	76.0	14.6	78.4	72.3	75.4	6.1
Oct. 12	81.0	65.6	73.3	15.4	76.0	69.0	72.5	7.0
Oct. 19	79.4	60.1	69.8	19.3	73.9	65.3	69.6	8.6
Oct. 26	74.3	61.0	67.6	13.3	70.1	64.3	67.2	5.8
Nov. 2	68.0	50.4	59.2	17.6	64.7	56.4	60.6	8.3
Nov. 9	62.3	46.0	54.1	16.3	59.0	52.4	55.7	6.6
Nov. 16	64.7	51.0	57.9	13.7	60.9	55.3	58.1	5.6
Nov. 23	62.6	52.0	57.3	10.6	60.0	55.4	57.7	4.6
Nov. 30	58.4	43.7	51.1	14.7	56.3	49.7	53.0	6.6
Dec. 7	55.7	48.0	51.9	7.7	54.7	51.7	53.2	3.0
Dec. 14	47.0	37.6	42.3	9.4	47.4	42.7	45.1	4.7
Dec. 21	47.0	37.7	42.4	9.3	45.9	42.1	44.0	3.8
Dec. 28	51.4	44.4	47.9	7.0	50.4	47.3	48.9	3.1
Jan. 4, '61	47.4	39.0	43.2	8.4	46.9	41.9	44.4	5.0
Jan. 11	49.4	40.3	44.9	9.1	48.0	44.0	46.0	4.0
Jan. 18	50.6	41.7	46.1	8.9	50.0	45.7	47.8	4.3
Jan. 25	41.7	36.1	38.9	5.6	43.4	40.3	41.8	3.1
Feb. 1	48.3	38.0	43.1	10.3	46.0	41.3	43.6	4.7
Feb. 8	47.4	40.3	43.9	7.1	46.4	42.7	44.6	3.7
Feb. 15	61.3	51.7	56.5	9.6	57.3	52.7	55.0	4.6
Feb. 22	58.4	52.0	55.2	6.4	57.7	54.1	55.9	3.6
Mar. 1	59.7	50.6	55.1	9.1	56.7	52.9	54.8	3.8
Mar. 8	67.0	53.1	60.1	13.9	62.4	56.1	59.3	6.3
Mar. 15	66.9	51.6	59.2	15.3	61.9	54.9	58.4	7.0
Mar. 22	69.7	49.9	59.8	19.8	63.0	54.1	58.6	8.9
Mar. 29	67.9	55.1	61.5	12.8	64.0	58.1	61.1	5.9
Apr. 5	64.3	47.9	56.1	16.4	60.4	53.0	56.7	7.4
Apr. 12	66.4	49.9	58.1	16.5	61.4	54.4	57.9	7.0
Apr. 19	71.7	51.7	61.7	20.0	65.1	55.7	60.4	9.4

TABLE 5 CONTINUED

Middle of Week	4-inch Soil Temp. - Degrees F.				8-inch Soil Temp. - Degrees F			
	Max. T4h	Min. T4l	Mean T4	Rise T4d	Max. T8h	Min. T8l	Mean T8	Ris T8d
Apr. 26, '61	79.0	62.4	70.7	16.6	72.4	65.0	68.7	7.4
May 3	77.3	60.0	68.6	17.3	71.1	63.3	67.2	7.8
May 10	79.0	62.3	70.6	16.7	72.9	65.1	69.0	7.8
May 17	86.7	67.4	77.1	19.3	79.4	70.4	74.9	9.0
May 24	86.0	66.7	76.3	19.3	73.9	71.3	75.6	8.6
May 31	93.6	68.3	80.9	25.3	83.9	71.8	77.8	12.1
June 7	89.6	73.1	81.4	16.5	81.9	75.0	78.4	6.9
June 14	85.4	73.0	79.2	12.4	81.4	75.4	78.4	6.0
June 21	79.9	67.3	73.6	12.6	76.1	69.9	73.0	6.2
June 28	87.4	70.7	79.1	16.7	81.1	73.1	77.1	8.0
July 5	89.9	72.4	81.1	17.5	83.0	75.0	79.0	8.0
July 12	83.9	71.6	77.7	12.3	79.6	73.4	76.5	6.2
July 19	89.3	74.3	81.8	15.0	83.1	76.3	79.7	6.8
July 26	92.3	75.1	83.7	17.2	85.7	77.4	81.6	8.3
Aug. 2	96.6	77.3	86.9	19.3	89.6	79.9	84.7	9.7
Aug. 9	93.4	75.9	84.6	17.5	87.7	78.9	83.3	8.8
Aug. 16	92.4	75.6	84.0	16.8	85.9	78.3	82.1	7.6
Aug. 23	92.4	72.6	82.5	19.8	85.4	75.6	80.5	9.8
Aug. 30	95.0	78.6	86.8	16.4	88.6	81.1	84.8	7.5
Sep. 6	90.3	75.9	83.1	14.4	84.7	78.3	81.5	6.4
Sep. 13	83.4	70.1	76.8	13.3	79.4	73.6	76.5	5.8
Sep. 20	87.3	68.3	77.8	19.0	81.1	71.3	76.2	9.8
Sep. 27	89.3	74.0	81.6	15.3	84.7	76.4	80.6	8.3
Oct. 4	74.3	60.1	67.2	14.2	73.4	64.3	68.8	9.1
Oct. 11	77.1	64.9	71.0	12.2	74.6	67.3	71.0	7.3
Oct. 18	73.7	58.9	66.3	14.8	71.9	62.3	67.1	9.6
Oct. 25	72.1	57.6	64.8	14.5	69.9	61.0	65.4	8.9
Nov. 1	74.0	64.0	69.0	10.0	72.0	65.9	69.0	6.1
Nov. 8	61.4	53.9	57.6	7.5	60.4	54.7	57.6	5.7
Nov. 15	63.6	58.1	60.8	5.5	63.1	59.7	61.4	3.4
Nov. 22	57.3	49.6	53.5	7.7	57.7	52.6	55.2	5.1
Nov. 29	56.1	47.7	51.9	8.4	56.6	50.9	53.8	5.7
Dec. 6	57.3	51.0	54.2	6.3	58.1	53.4	55.8	4.7
Dec. 13	52.3	48.0	50.2	4.3	53.4	50.3	51.8	3.1
Dec. 20	52.0	46.4	49.2	5.6	53.3	48.7	51.0	4.6
Dec. 27	44.4	38.9	41.6	5.5	46.1	42.0	44.0	4.1
Jan. 3, '62	48.3	41.3	44.8	7.0	48.9	43.9	46.4	5.0
Jan. 10	41.0	38.3	39.6	2.7	42.4	40.0	41.2	2.4
Jan. 17	44.6	39.6	42.1	5.0	45.6	41.3	43.4	4.3
Jan. 24	55.7	49.4	52.6	6.3	54.9	50.0	52.4	4.9
Jan. 31	56.7	46.0	51.4	10.7	55.4	48.0	51.7	7.4
Feb. 7	54.0	46.0	50.0	8.0	53.6	47.9	50.8	5.7
Feb. 14	60.7	50.3	55.5	10.4	59.1	51.6	55.4	7.5
Feb. 21	60.4	53.3	56.8	7.1	59.1	54.1	56.6	5.0
Feb. 28	60.1	52.4	56.2	7.7	57.9	52.9	55.4	5.0
Mar. 7	52.3	45.4	48.8	6.9	51.6	46.4	49.0	5.2
Mar. 14	56.1	46.9	51.5	9.2	55.0	47.9	51.4	7.1
Mar. 21	60.3	51.0	55.6	9.3	59.0	52.0	55.5	7.0
Mar. 28	64.7	57.4	61.0	7.3	63.1	56.4	59.8	6.7
Apr. 4	60.3	53.4	56.8	6.9	59.9	53.4	56.6	6.5
Apr. 11	68.7	59.9	64.3	8.8	66.6	59.7	63.2	6.9
Apr. 18	69.7	56.9	63.3	12.8	66.2	57.6	61.9	8.6
Apr. 25	77.9	64.0	71.0	13.9	73.0	64.3	68.6	8.7
May 2	81.3	66.1	73.7	15.2	76.1	66.4	71.2	9.7
May 9	86.4	70.3	78.4	16.1	82.6	70.4	76.5	12.2
May 16	89.1	74.3	81.7	14.8	85.9	75.1	80.5	10.8
May 23	88.6	76.3	82.4	12.3	85.9	77.3	81.6	8.6

ABLE 5 CONTINUED

	4-inch Soil Temp. - Degrees F.				8-inch Soil Temp. - Degrees F.			
Middle of Week	Max. T4h	Min. T4l	Mean T4	Rise T4d	Max. T8h	Min. T8l	Mean T8	Rise T8d
May 30, '62	86.1	75.1	80.6	11.0	83.1	75.3	79.2	7.8
June 6	88.3	75.0	81.6	13.3	83.6	74.4	79.0	9.2
June 13	93.3	76.9	85.1	16.4	85.3	76.9	81.1	8.4
June 20	99.6	80.3	90.0	19.3	89.7	80.3	85.0	9.4
June 27	97.9	78.6	88.2	19.3	88.4	78.9	83.6	9.5
July 4	100.6	80.7	90.6	19.9	91.0	80.9	86.0	10.1
July 11	101.6	82.4	92.0	19.2	92.3	82.9	87.6	9.4
July 18	101.9	82.1	92.0	19.8	92.4	83.0	87.7	9.4
July 25	96.6	80.1	88.4	16.5	89.0	81.1	85.0	7.9
Aug. 1	93.3	77.4	85.4	15.9	85.1	79.0	82.0	6.1
Aug. 8	103.0	81.1	92.0	21.9	91.3	82.0	86.2	9.3
Aug. 15	102.4	81.4	91.9	21.0	90.9	81.1	86.0	9.8
Aug. 22	96.7	79.1	87.9	17.6	87.1	81.0	84.1	6.1
Aug. 29	99.6	79.4	89.5	20.2	87.3	80.4	83.8	6.9
Sep. 5	96.0	78.4	87.2	17.6	85.7	80.0	82.8	5.7
Sep. 12	96.4	79.7	88.0	16.7	86.7	80.0	83.4	6.7
Sep. 19	93.9	74.6	84.2	19.3	84.4	77.1	80.8	7.3
Sep. 26	89.9	67.4	78.6	22.5	81.3	72.7	77.0	8.6
Oct. 3	86.9	66.4	76.6	20.5	78.6	69.9	74.2	8.7
Oct. 10	87.1	70.1	78.6	17.0	79.9	72.3	76.1	7.6
Oct. 17	86.4	68.0	77.2	18.4	78.0	71.3	74.6	6.7
Oct. 24	75.4	57.3	66.4	18.1	69.9	63.6	66.8	6.3
Oct. 31	73.6	57.7	65.6	15.9	67.9	62.0	65.0	5.9
Nov. 7	67.6	53.4	60.5	14.2	63.1	57.7	60.4	5.4
Nov. 14	67.0	50.9	59.0	16.1	62.4	56.1	59.2	6.3
Nov. 21	59.4	48.4	53.9	11.0	57.7	53.4	55.6	4.3
Nov. 28	60.1	49.7	54.9	10.4	57.4	53.3	55.4	4.1
Dec. 5	58.3	45.3	51.8	13.0	56.0	51.1	53.6	4.9
Dec. 12	42.7	34.3	38.5	8.4	45.3	41.3	43.3	4.0
Dec. 19	57.4	47.0	52.2	10.4	54.0	49.6	51.8	4.4
Dec. 26	47.9	41.9	44.9	6.0	49.1	46.4	47.8	2.7
Jan. 2, '63	51.1	40.0	45.6	11.1	49.0	44.6	46.8	4.4
Jan. 9	53.4	44.7	49.0	8.7	52.0	48.0	50.0	4.0
Jan. 16	43.0	38.0	40.5	5.0	44.7	41.3	43.0	3.4
Jan. 23	41.1	34.0	37.6	7.1	43.1	39.1	41.1	4.0
Jan. 30	44.7	38.0	41.4	6.7	44.0	40.4	42.2	3.6
Feb. 6	50.0	40.6	45.3	9.4	48.3	43.3	45.8	5.0
Feb. 13	48.1	38.4	43.2	9.7	46.6	41.6	44.1	5.0
Feb. 20	46.1	37.7	41.9	8.4	45.0	40.3	42.6	4.7
Feb. 27	52.0	41.3	46.6	10.7	48.9	43.6	46.2	5.3
Mar. 6	59.6	48.1	53.8	11.5	55.3	50.0	52.6	5.3
Mar. 13	63.9	54.9	59.4	9.0	59.7	54.7	57.2	5.0
Mar. 20	66.6	56.9	61.8	9.7	62.6	57.7	60.2	4.9
Mar. 27	68.3	57.7	63.0	10.6	62.9	58.0	60.4	4.9
Apr. 3	72.6	60.7	66.6	11.9	67.3	61.9	64.6	5.4
Apr. 10	81.1	60.0	70.6	21.1	71.3	61.6	66.4	9.7
Apr. 17	86.4	64.4	75.4	22.0	75.7	65.3	70.5	10.4
Apr. 24	77.7	64.3	71.0	13.4	72.6	66.3	69.4	6.3
May 1	79.1	61.1	70.1	18.0	71.6	63.7	67.6	7.9
May 8	91.1	70.1	80.6	21.0	79.4	70.6	75.0	8.8
May 15	91.4	75.7	83.6	15.7	82.4	75.4	78.9	7.0
May 22	89.3	70.7	80.0	18.6	81.6	73.0	77.3	8.6
May 29	85.3	69.2	77.2	16.1	78.4	71.0	74.7	7.4
June 5	97.1	75.0	86.0	22.1	86.3	75.7	81.0	10.6
June 12	98.1	81.0	89.6	17.0	89.0	80.9	85.0	8.1
June 19	87.6	76.1	81.8	11.5	82.3	77.1	79.7	5.2

TABLE 5 CONTINUED

Middle of Week	4-inch Soil Temp. - Degrees F.				8-inch Soil Temp. - Degrees F.			
	Max. T4h	Min. T4l	Mean T4	Rise T4d	Max. T8h	Min. T8l	Mean T8	Rise T8d
June 26, '63	85.9	75.4	80.6	10.5	81.6	75.9	78.8	5.7
July 3	92.1	79.9	86.0	12.2	86.1	79.0	82.6	7.1
July 10	90.9	77.4	84.2	13.5	85.6	78.4	82.0	7.2
July 17	89.0	76.2	82.6	12.8	82.4	77.0	79.7	5.4
July 24	89.9	77.2	83.6	12.7	83.7	78.6	81.2	5.1
July 31	93.3	79.4	86.4	13.9	85.6	79.7	82.6	5.9
Aug. 7	97.9	81.9	89.9	16.0	88.4	81.9	85.2	6.5
Aug. 14	92.3	77.9	85.1	14.4	84.9	79.0	82.0	5.9
Aug. 21	94.9	78.3	86.6	16.6	86.7	79.1	82.9	7.6
Aug. 28	94.7	81.1	87.9	13.6	87.6	81.4	84.5	6.2
Sep. 4	93.7	78.1	85.9	15.6	86.0	79.3	82.6	6.7
Sep. 11	92.1	77.0	84.6	15.1	84.1	78.0	81.0	6.1
Sep. 18	86.4	73.9	80.2	12.5	81.9	74.6	78.2	7.3
Sep. 25	82.9	71.6	77.2	11.3	78.1	72.3	75.2	5.8
Oct. 2	81.4	66.9	74.2	14.5	76.4	68.3	72.4	8.1
Oct. 9	86.7	69.9	78.3	16.8	79.0	70.7	74.8	8.3
Oct. 16	84.0	69.1	76.6	14.9	78.0	70.7	74.4	7.3
Oct. 23	79.6	67.6	73.6	12.0	75.3	69.4	72.4	5.9
Oct. 30	72,6	58.4	65.5	14.2	69.6	63.1	66.4	6.5
Nov. 6	65.1	56.0	60.6	9.1	63.0	58.6	60.8	4.4
Nov. 13	63.1	52.1	57.6	11.0	61.1	55.3	58.2	5.8
Nov. 20	67.4	59.7	63.6	7.7	65.4	60.7	63.0	4.7
Nov. 27	58.4	51.4	54.9	7.0	57.4	54.0	55.7	3.4
Dec. 4	54.0	45.7	49.8	8.3	52.4	47.9	50.2	4.5
Dec. 11	51.3	43.7	47.5	7.6	49.4	46.9	48.2	2.5
Dec. 18	41.7	37.1	39.4	4.6	42.3	40.1	41.2	2.2
Dec. 25	42.9	37.9	40.4	5.0	43.0	40.1	41.6	2.9
Jan. 1, '64	44.3	39.7	42.0	4.6	44.4	41.4	42.9	3.0
Jan. 8	49.3	43.1	46.2	6.2	48.7	44.7	46.7	4.0
Jan. 15	41.1	36.1	38.6	5.0	41.1	38.7	39.9	2.4
Jan. 22	52.7	46.7	49.7	6.0	51.3	47.1	49.2	4.2
Jan. 29	51.0	43.6	47.3	7.4	49.1	45.0	47.0	4.1
Feb. 5	49.9	43.6	46.8	6.3	48.7	45.6	47.2	3.1
Feb. 12	49.6	42.4	46.0	7.2	48.1	44.0	46.0	4.1
Feb. 19	49.1	42.4	45.8	6.7	47.9	44.1	46.0	3.8
Feb. 26	50.0	42.6	46.3	7.4	48.6	44.0	46.3	4.6
Mar. 4	56.1	49.7	52.9	6.4	54.0	50.1	52.0	3.9

TABLE 6 - DAILY AVERAGES FOR WEEKS OF 2 AND 16 INCH SOIL TEMPERATURES

	2-inch Soil Temp. - Degrees F.				16-inch Soil Temp. - Degrees F.			
liddle of Week	Max. T2h	Min. T2l	Mean T2	Rise T2d	Max. T16h	Min. T16l	Mean T16	Rise T16d
Aug. 16, '61	90.6	75.6	83.1	15.0	79.8	78.2	79.0	1.6
Aug. 23	92.3	73.3	82.8	19.0	79.7	77.4	78.6	2.3
Aug. 30	95.7	79.0	87.4	16.7	81.4	80.0	80.7	1.4
Sep. 6	90.0	75.5	82.8	14.5	80.6	79.3	80.0	1.3
Sep. 13	82,9	69,9	76.4	13.0	77.3	75.9	76.6	1.4
Sep. 20	88.1	67.6	77.8	20.5	75.4	73.4	74.4	2.0
Sep. 27	92.7	73.4	83.0	19.3	78.4	77.0	77.7	1.4
Oct. 4	76.4	59.0	67.7	17.4	71.7	68.9	70.3	2.8
Oct. 11	79.1	63.3	71.2	15.8	71.1	69.4	70.2	1.7
Oct. 18	78.6	56.0	67.3	22.6	68.4	66.9	67.6	1.5
Oct. 25	76.7	55.7	66.2	21.0	66.4	64.9	65.6	1.5
Nov. 1	76.6	62.9	69.8	13.7	67.0	66.1	66.6	0.9
Nov. 8	62.9	48.3	55.6	14.6	60.1	58.5	59.3	1.6
Nov. 15	63.6	57.1	60.4	6.5	62.3	60.3	61.3	2.0
Nov. 22	59.7	47.1	53.4	12.6	56.7	56.0	56.4	0.7
Nov. 29	59.6	45.3	52.4	14.3	55.7	54.1	54.9	1.6
Dec. 6	58.7	49.6	54.2	9.1	56.9	55.0	56.0	1.9
Dec. 13	52.9	46.3	49.6	6.6	53.3	51.9	52.6	1.4
Dec. 20	53.7	43.9	48.8	9.8	52.2	51.0	51.6	1.2
Dec. 27	47.0	36.4	41.7	10.6	46.7	45.6	46.2	1.1
Jan. 3, '62	50.4	40.1	45.2	10.3	46.6	45.1	45.9	1.5
Jan. 10	40.0	35.7	37.8	4.3	44.1	43.1	43.6	1.0
Jan. 17	46.9	37.9	42.4	9.0	44.4	43.3	43.8	1.1
Jan. 24	57.3	48.6	53.0	8.7	50.7	48.4	49.6	2.3
Jan. 31	61.0	43.6	52.3	17.4	51.7	50.6	51.2	1.1
Feb. 7	56.4	43.9	50.2	12.5	52.0	50.1	51.0	1.9
Feb. 14	64.6	48.4	56.5	16.2	54.6	53.0	53.8	1.6
Feb. 21	63.0	51.3	57.2	11.7	55.7	54.3	55.0	1.4
Feb. 28	59.9	51.1	55.5	8.8	57.1	55.1	56.1	2.0
Mar. 7	53.1	42.0	47.6	11.1	50.6	49.7	50.2	0.9
Mar. 14	59.7	43.3	51.5	16.4	52.0	50.9	51.4	1.1
Mar. 21	64.3	48.3	56.3	16.0	54.9	53.0	54.0	1.0
Mar. 28	69.3	52.9	61.1	16.4	58.4	57.3	57.8	1.1
Apr. 4	64.3	49.4	56.8	14.9	57.1	56.1	56.6	1.0
Apr. 11	73.1	56.0	64.6	17.1	62.1	60.4	61.2	1.7
Apr. 18	75.3	51.3	63.3	24.0	62.1	60.4	61.2	1.7
Apr. 25	84.1	60.7	72.4	23.4	66.9	65.1	66.0	1.8
May 2	87.3	62.1	74.7	25.2	69.7	67.9	68.8	1.8
May 9	97.9	66.6	82.2	31.3	72.9	71.1	72.0	1.8
May 16	100.7	72.0	86.4	28.7	76.3	75.0	75.6	1.3
May 23	99.6	74.0	86.8	25.6	78.1	76.6	77.4	1.5
May 30	93.1	71.9	82.5	21.2	77.7	76.0	76.8	1.7
June 6	92.4	71.4	81.9	21.0	78.4	76.9	77.6	1.5
June 13	95.4	72.7	84.0	22.7	80.3	78.9	79.6	1.4
June 20	101.1	76.9	89.0	24.2	83.3	81.6	82.4	1.7
June 27	99.9	74.6	87.2	25.3	83.1	81.1	82.1	2.0
July 4	102.9	77.3	90.1	25.6	84.4	82.6	83.5	1.8
July 11	103.7	79.0	91.4	24.9	85.9	84.3	85.1	1.6
July 18	104.7	78.7	91.7	26.0	86.3	84.9	85.6	1.4
July 25	97.9	76.7	87.3	21.2	85.0	83.3	84.2	1.7
Aug. 1	93.0	74.7	83.8	18.3	83.1	81.3	82.2	1.8
Aug. 8	103.0	78.1	90.6	24.9	85.6	84.1	84.8	1.5
Aug. 15	102.7	78.6	90.6	24.1	86.0	84.7	85.4	1.3
Aug. 22	96.0	76.6	86.3	19.4	84.6	83.3	84.0	1.3

TABLE 6 CONTINUED

Middle of Week	2-inch Soil Temp. - Degrees F. Max. T2h	Min. T2l	Mean T2	Rise T2d	16-inch Soil Temp. - Degrees F Max. T16h	Min. T16l	Mean T16	Rise T16d
Aug. 29, '62	95.6	76.7	86.2	18.9	84.3	82.9	83.6	1.4
Sep. 5	92.0	76.1	84.0	15.9	83.9	82.4	83.2	1.5
Sep. 12	97.0	76.9	87.0	20.1	82.9	81.9	82.4	1.0
Sep. 19	93.7	71.1	82.4	22.6	81.6	80.3	81.0	1.3
Sep. 26	89.6	64.1	76.8	25.5	78.9	77.7	78.3	1.2
Oct. 3	86.7	63.9	75.3	22.8	76.0	74.8	75.4	1.2
Oct. 10	87.0	67.1	77.0	19.9	76.7	75.4	76.0	1.3
Oct. 17	86.7	64.7	75.7	22.0	76.3	75.0	75.6	1.3
Oct. 24	75.6	54.1	64.8	21.5	70.9	69.3	70.1	1.6
Oct. 31	73.1	55.0	64.0	18.1	67.9	66.7	67.3	1.2
Nov. 7	67.3	49.0	58.2	18.3	63.9	63.0	63.4	0.9
Nov. 14	65.7	48.3	57.0	17.4	62.0	61.0	61.5	1.0
Nov. 21	58.6	46.9	52.8	11.7	58.7	57.7	58.2	1.0
Nov. 28	59.1	48.1	53.6	11.0	57.3	56.7	57.0	0.6
Dec. 5	56.7	43.3	50.0	13.4	57.0	55.4	56.2	1.6
Dec. 12	41.9	32.6	37.2	9.3	48.1	46.1	47.1	2.0
Dec. 19	57.6	44.9	51.2	12.7	52.3	50.7	51.5	1.6
Dec. 26	47.3	40.7	44.0	6.6	50.0	49.1	49.6	0.9
Jan. 2, '63	51.4	38.6	45.0	12.8	48.4	47.7	48.0	0.7
Jan. 9	53.4	43.3	48.4	10.1	50.7	49.4	50.0	1.3
Jan. 16	42.4	36.3	39.4	6.1	46.4	44.7	45.6	1.7
Jan. 23	40.9	32.7	36.8	8.2	44.3	42.6	43.4	1.7
Jan. 30	45.3	36.7	41.0	8.6	43.0	41.4	42.2	1.6
Feb. 6	50.4	38.3	44.4	12.1	47.3	46.0	46.6	1.3
Feb. 13	48.9	36.0	42.4	12.9	45.9	45.0	45.4	0.9
Feb. 20	47.0	35.4	41.2	11.6	44.3	43.3	43.8	1.0
Feb. 27	54.0	39.1	46.6	14.9	46.3	45.3	45.8	1.0
Mar. 6	61.0	45.1	53.0	15.9	52.3	50.9	51.6	1.4
Mar. 13	63.9	51.9	57.9	12.0	56.7	55.0	55.8	1.7
Mar. 20	67.7	54.6	61.2	13.1	59.9	58.1	59.0	1.8
Mar. 27	68.4	55.0	61.7	13.4	60.0	59.3	59.6	0.7
Apr. 3	74.0	58.4	66.2	15.6	64.1	62.9	63.5	1.2
Apr. 10	83.1	56.7	69.9	26.4	66.0	63.6	64.8	2.4
Apr. 17	90.0	61.6	75.8	28.4	68.7	66.6	67.6	2.1
Apr. 24	79.0	61.6	70.3	17.4	69.7	67.6	68.6	2.1
May 1	80.4	57.9	69.2	22.5	68.3	66.1	67.2	2.2
May 8	92.6	67.3	80.0	25.3	74.1	72.0	73.0	2.1
May 15	94.6	73.0	83.8	21.6	77.7	76.1	76.9	1.6
May 22	92.1	67.4	79.8	24.7	76.9	74.9	75.9	2.0
May 29	87.0	66.7	76.8	20.3	74.6	73.1	73.8	1.5
June 5	101.4	71.7	86.6	29.7	79.6	77.6	78.6	2.0
June 12	104.0	78.6	91.3	25.4	82.3	81.3	81.8	1.0
June 19	90.0	73.6	81.8	16.4	80.0	78.6	79.3	1.4
June 26	89.9	72.4	81.2	17.5	78.6	77.6	78.1	1.0
July 3	97.6	76.1	86.8	21.5	81.7	80.6	81.2	1.1
July 10	95.3	73.1	84.2	22.2	82.1	81.1	81.6	1.0
July 17	88.9	73.6	81.2	15.3	80.7	79.0	79.8	1.7
July 24	89.7	74.4	82.0	15.3	81.6	80.9	81.2	0.7
July 31	92.4	76.4	84.4	16.0	83.0	81.7	82.4	1.3
Aug. 7	97.9	78.1	88.0	19.8	85.4	84.3	84.8	1.1
Aug. 14	93.6	74.3	84.0	19.3	83.4	82.0	82.7	1.4
Aug. 21	97.4	75.3	86.4	22.1	83.6	82.0	82.8	1.6
Aug. 28	96.9	78.3	87.6	18.6	85.0	83.6	84.3	1.4
Sep. 4	95.6	75.0	85.3	20.6	83.4	82.4	82.9	1.0
Sep. 11	92.0	73.3	82.6	18.7	83.0	81.4	82.2	1.6
Sep. 18	90.1	70.1	80.1	20.0	79.4	78.4	78.9	1.0

TABLE 6 CONTINUED

Middle of Week	2-inch Soil Temp. - Degrees F.				16-inch Soil Temp. - Degrees F.			
	Max. T2h	Min. T2l	Mean T2	Rise T2d	Max. T16h	Min. T16l	Mean T16	Rise T16d
Sep. 25, '63	83.6	65.7	74.6	17.9	78.1	77.1	77.6	1.0
Oct. 2	84.7	62.0	73.4	22.7	74.3	73.3	73.8	1.0
Oct. 9	89.4	64.9	77.2	24.5	76.0	75.1	75.6	0.9
Oct. 16	87.1	64.4	75.8	22.7	75.4	75.0	75.2	0.4
Oct. 23	82.3	64.0	73.2	18.3	73.7	73.0	73.4	0.7
Oct. 30	74.3	52.3	63.3	22.0	70.9	69.3	70.1	1.6
Nov. 6	65.3	51.1	58.2	14.2	64.9	63.4	64.2	1.5
Nov. 13	65.0	47.1	56.0	17.9	62.3	61.3	61.8	1.0
Nov. 20	68.7	56.0	62.4	12.7	64.3	63.0	63.6	1.3
Nov. 27	57.6	46.6	52.1	11.0	59.9	58.7	59.3	1.2
Dec. 4	54.3	40.1	47.2	14.2	54.0	53.3	53.6	0.7
Dec. 11	47.9	39.3	43.6	8.6	50.9	49.4	50.2	1.5
Dec. 18	38.9	34.1	36.5	4.8	45.3	44.7	45.5	1.6
Dec. 25	42.7	35.3	39.0	7.4	43.9	42.6	43.2	1.3
Jan. 1, '64	43.3	36.1	39.7	7.2	45.3	44.1	44.7	1.2
Jan. 8	49.4	38.4	43.9	11.0	48.0	47.1	47.6	0.9
Jan. 15	39.0	33.6	36.3	5.4	43.1	42.1	42.6	1.0
Jan. 22	53.9	44.0	49.0	9.9	48.7	47.3	48.0	1.4
Jan. 29	52.3	39.7	46.0	12.6	49.0	47.7	48.4	1.3
Feb. 5	50.3	39.1	44.7	11.2	48.9	48.0	48.4	0.9
Feb. 12	51.4	38.1	44.8	13.3	47.1	46.6	46.8	0.5
Feb. 19	50.1	37.7	43.9	12.4	47.1	46.7	46.9	0.4
Feb. 26	52.1	38.7	45.4	13.4	46.7	46.1	46.4	0.6
Mar. 4	58.4	46.6	52.5	11.8	52.1	50.4	51.2	1.7

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Changes In The Occupational Structure Of Mississippi And The South 1950 - 1960

Mississippi State University
AGRICULTURAL EXPERIMENT STATION
HENRY LEVECK, Director
STATE COLLEGE MISSISSIPPI

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CHANGES IN THE OCCUPATIONAL STRUCTURE OF MISSISSIPPI AND THE SOUTH, 1950-1960

BY ELISABETH J. STOJANOVIC

In improving its economic status, Mississippi relies heavily on physical resources. The full realization of the benefits from these resources depends largely upon an adequate labor force, made up of many individuals representing various walks of life. The more skilled and better trained this labor pool becomes. the closer and the more readily attainable may be the goals for raising the level of living of its citizens.

The objective of this report is to elucidate the changes which have occurred chiefly among four major occupational groupings in Mississippi, namely the white collar, manual, service, and agricultural workers, between 1950 and 1960. Also, where appropriate, comparisons will be made with the changes in the South in general over the same period It is anticipated that focusing on the outstanding changes in the human resources of the State may develop an awareness of the trends in the occupational structure of Mississippi employment and may assist in projecting future employment opportunities.

Trends in Total Employment

During the decade 1950 to 1960, the total number of employed males in Mississippi, 14 years of age and over, decreased by 15.9 percent, whereas the number of employed females in the same age category increased 28.7 percent. For the South, on the other hand, both male and female workers increased, namely 3.4 and 38.2 percent, respectively.

When the white and nonwhite segments of the Mississippi population of both sexes are considered separately, the changes in employment become even more striking. A relatively small decrease, 5.6 percent, was depicted for white male workers and a quite large decline, 30 percent, for the nonwhite segment of the employed workers. The latter was also true for the South as a whole, although the decrease was slightly over 10 percent. Female workers increased both in Mississippi and regionally, with the most pronounced changes occurring among whites (Table 1).

The overall picture is quite similar for persons who reported their occupation. Male workers decreased by 16.8 percent, while the female workers had gained 27.4 percent.

A decline in the male labor force was also observed for the 1940-1950 period. and thus seems to be a continuation of an earlier trend, which actually started during the 1930's.[2] Indications are that those losses are due mainly to a continuous migration from the State, which is particularly sizeable in the nonwhite category.

The same trend is also holding for the South in general, but only for the nonwhite segment. The decrease, however. was substantially smaller. The outstanding changes in the major occupational groupings are shown in Table 2. It is evident that except for agricultural workers for both Mississippi and the South, all other occupations have grown between 1950 and 1960. Interestingly, for the first time white collar workers numerically overtook the manual workers. In Mississippi this is true only for the male workers. In the female group, the bulk of employment is still of the manual type. The agricultural workers decreased roughly by one half, a trend consistent with the State and the region, as well as with both sexes.

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[1] This report is based on 1950 and 1960 decennial census data.

[2] U. S. Bureau of the Census, **1950 Census of Population**, Vol. II, Part 24, Table 26.

Table 1. Percent change in total employed persons by race, sex, and occupational groups, in Mississippi and the South, 1950-1960.

	Mississippi		The South	
	Male	Female	Male	Female
		percent		
Changes by Race				
White	– 5.6	52.1	6.8	45.6
Nonwhite	–30.0	4.7	–10.2	18.1
Changes by Occupational Groupings		percent		
White collar workers	19.3	40.2	26.8	46.8
Manual workers	18.1	75.8	10.3	25.0
Service workers	15.7	45.6	15.5	37.0
Agricultural workers	–54.0	–51.2	–50.1	–44.7

Sources: U. S. Bureau of the Census, **1950 Census of Population**, Vol. II, Part 24, Mississippi. Table 28 and **U. S. Census of Population, 1960**, PC(1), 26D, Mississippi, Table 121, and PC(1) 1D, United States, Table 257.

In general, the changes continue to accentuate the trends observed in earlier decennial censuses. These changes, however, do not reveal in which occupational groupings the greatest or most drastic shifts have occurred. In an attempt to throw some light in this direction each of the four above-mentioned major occupational groups will be considered separately.[3]

White Collar Workers

This occupational group consists of a wide spectrum of civilian professional and technical personnel. For the purpose of this report occupations belonging to the following categories will be considered: 1) Professional workers, such as engineers, natural scientists, medical and health workers, teachers, and other professional and technical workers, including accountants, lawyers, etc.; 2) Managers, officials, and proprietors (farm excluded); 3) Clerical workers, and 4) Sales workers.

For both sexes and both races, the professional workers were the fastest growing occupational group between 1950 and 1960. This seems to reflect the State's greater emphasis on the technological advances, the application of scientific discovery to industrial uses, better medical and educational services, and in general a dynamic tendency in all sorts of enterprises.

The recent expansion in the existing space programs throughout the South and the initiation of new ones in Mississippi have undoubtedly contributed to the rise of this professional group, particularly in the fields of engineering, physics, and mathematics. The teaching profession has also contributed to this increase, particularly at the elementary and secondary school level. A quite fast increase in the number of school-age children created a need for more teachers.

The white managerial workers group increased more slowly than the professional. On the other hand, nonwhite workers were drastically reduced. Apparently, the changes in the ways in which nowadays' business matters are conducted, as well as their modification in scope, required more specialized training and thus might have forced the decline in certain categories of this group.

Notwithstanding the introduction of more modern and efficient office equipment for data processing, clerical workers generally increased sharply. Steady influx of industry in the State, and in the South in general, seems to have created a greater demand for manpower for collecting data, programming the results, and for operating computing machines, as well as cashiers. As shown by the percentage increases in Table 2, women in this category appear to be in far greater demand than men. Secretaries, stenographers, and typists represent the majority of jobs filled.

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[3] Only those reporting their occupation are included in this report.

Moderate increases are also noted for sales workers, except for nonwhite males in Mississippi, which category suffered a sharp decline. It is assumed that whatever growth was registered, it was largely due to the handling of retail trade by part-time workers.

Manual Workers

In this group are included: 1) Craftsmen, foremen, and kindred workers, such as construction craftsmen, mechanics and repairmen, metal craftsmen, except mechanics, and other craftsmen; 2) Operative and kindred workers, such as drivers and similar workers, and 3) Laborers. except farm and mine.

Table 2 shows that craftsmen, foremen, and kindred workers increased with both races and both sexes, with the white females having an exceptionally sharp increase. Census figures indicate that the observed increases were essentially among foremen, mechanics, and repairmen. The latter two groups were in greater demand as the ever increasing use of complicated machinery and apparatus requires a larger force of trained individuals for their service and upkeep. The only slight rise in construction craftsmen may be explained by a limited demand for such services due to a greater tendency of using prefabricated materials for building purposes. Nevertheless, electrical workers and brickmasons remained in demand and their numbers show the greatest escalation among construction craftsmen.

The extremely large ascent in the white female craftmen category was brought about by the more than doubling of the number of women employed as decorators, window dressers, and textile work-

Table 2. Percent change of employed workers by occupation, sex, and race, in Mississippi and the South, 1950-1960.

	Mississippi				The South			
	Male		Female		Male		Female	
Occupation	White	Non-White	White	Non-white	White	Non-white	white	Non-white
				percent				
White collar workers								
Professional	29.6	23.3	36.0	34.6	54.2	33.0	48.6	42.9
Managerial	19.5	– 8.2	26.8	—20.8	18.3	—12.0	27.1	– 8.5
Clerical	25.7	35.8	61.0	37.0	20.8	59.2	56.8	81.8
Sales	7.9	—15.5	21.6	1.0	19.1	2.8	29.1	9.8
Manual workers								
Craftsmen, etc.	33.4	19.6	94.4	2.2	19.5	22.2	26.0	40.2
Operatives, etc.	44.0	6.1	100.8	11.2	11.0	9.2	27.7	8.8
Laborers	– 9.7	—10.9	– 6.1	– 6.3	– 2.7	—11.0	1.8	—12.5
Service workers								
Service wks. exc. private household	17.0	19.2	61.3	32.4	20.7	11.8	57.1	37.9
Private household	12.3	15.9	222.8	40.6	0.5	—20.0	67.1	18.4
Agricultural workers								
Farmers and farm mgrs.	—59.4	—71.2	—28.2	—63.4	—50.4	—66.8	13.9	—52.6
Farm laborers and foremen	—53.7	– 1.7	—60.5	—44.2	—48.2	—29.4	—52.4	—50.2

Sources: **U. S. Census of Population, 1950**, Vol. II, Part 24, Miss , Table 28; **U. S. Census of Population, 1960**, PC(1), 26D, Miss., Table 121, and PC(1), 1D, U. S., Table 257.

ers during the decade from 1950 to 1960.[4] This, in turn, was encouraged by an expanded building program of both private homes and business establishments, and by bringing into the State more industry which offered employment opportunities for women.

Among the manual workers, operatives, laborers, and kindred workers were by far the largest group, showing the greatest increases, specifically among the whites. For example, in Mississippi male employment increased by 44 percent and the proportion of females employed in this category more than doubled, and was a more than four-fold increase over that of the entire South. Drivers and deliverymen exhibited the largest growth, probably due to the greater number of trucks needed for transporting goods across the country.

The reason for the more than double increase in the State's female workers in this cagetory may be sought in the increasing demand for checkers, examiners, inspectors, assemblers, packers, wrappers, and particularly in sewing and stitching jobs, which more than doubled during the last decade. Increases in employment of women are also evident in the food industry, specifically in the areas of perishable goods and in the handling of textile goods.

Figures on industrial manual workers, on the other hand, show a decline, resulting from a greater emphasis on mechanical devices, which are substituting for manpower. This is particularly true with such jobs where heavy objects are moved, and where excavations are made. For both races, the declines were greater in the male labor category than in that of the female.

For the South, the descending order is of far greater magnitude and in a somewhat reverse order. It is evident from Table 2 that the chief decline occurred in the white male laborers group and in the nonwhite female category. The white females maintained a slight upward trend.

Service Workers, Including Private Household Workers

This occupational group may be subdivided into two categories 1) Service workers, except private household, such as protective service workers, waiters, bartenders, cooks, and counter workers, and 2) Private household workers such as cooks, laundresses, baby sitters, housekeepers, etc.

The women workers of the first category increased sharply in Mississippi and in the South during the 1950 to 1960 decade. The rise in the number of male workers was somewhat smaller, although it continued to maintain an upward trend. Census data indicate that primarily waiters, bartenders, cook, and counter workers were involved in the augmentation of numbers. This, in turn, may be construed as reflecting the change in the people's living habits, such as a tendency for many to eat away from home, as well as to take pleasure trips.

Private household workers of both sexes and both races in Mississippi also increased with white females increasing more than 200 percent. The pick-up in this occupational group reversed the drastic drop of the 1940-1950 decade. The increase is largely attributed to the employment in babysitting, as well as to the upward trend of employed housekeepers.

Agricultural Workers

The agricultural workers group consists of: 1) Farmers and farm managers, and 2) Farm laborers and farm foremen.

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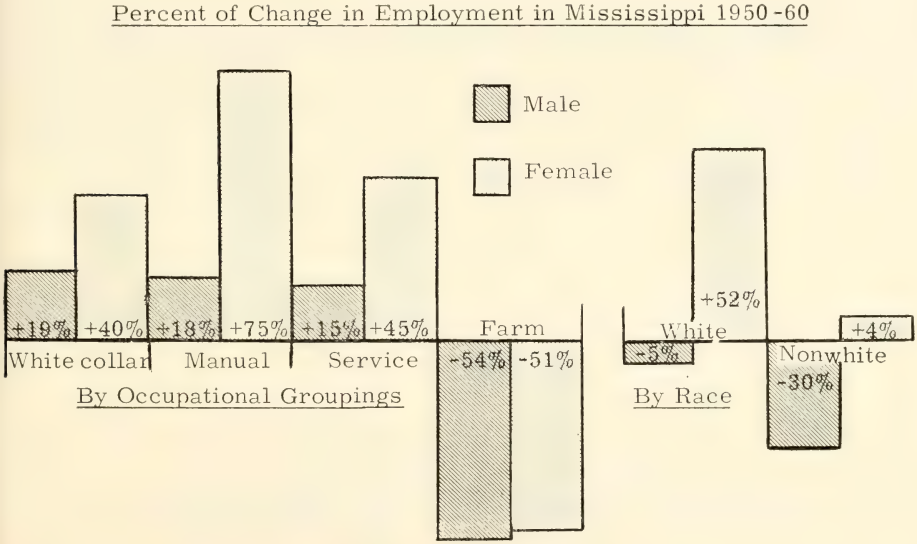
[4] U. S. Bureau of the Census, **United States Census of Population, 1960**, PC(1), 26D. Table 120.

Ever since 1920 there has been a steady drain on farm labor which gradually became nonfarm labor. This trend has become more and more pronounced in recent years, featuring sharp declines in this category. Except for women workers of both races in the South, there were sharp declines across the board between 1950 and 1960, with both farmers and farm managers, and farm laborers and farm foremen declining both in number and in proportion of the total employed. (Table 2)

The reasons for the decline may be sought in the improved farm practices, such as better crop breeding techniques, improvement and maintenance of soil fertility, use of more and modern equipment, and larger farms which escalate the output per farm worker man-hour as much as 70 percent. As a result thereof, many marginal farmers were forced to shift to nonfarm occupations, adding to a larger decline in this category.

Concurrent with the writing of this report, the daily press reports that the decline in the agricultural work force in Mississippi continues the descending trend, despite record harvests. The annual report, prepared by the State Employment Service's Farm Placement Department, shows that the 1964 seasonal work force included 47,600 workers, compared with 55,700 the year before. Reasons given for the decline were the greater use of pest control measures, favorable weather, and optimum use of machines to harvest the crop. The report also pointed at the tendency toward stabilization of employment of nonseasonal hired workers despite the decline in the number of farms. This information is additional evidence on the continuous declining trend in the number of farm workers required, and of the fact that many men are being replaced by machines in an increasingly intense and mechanized type of agriculture.



Analysis of census figures shows some striking changes in employment in Mississippi from 1950 to 1960. There was a sharp increase in female employment, a rather heavy decline in workers on farms, and a relative gain in white over non-white employment.

BULLETIN 717 NOVEMBER 1965

Interstate Migration

# of the

Mississippi Population

1960

By GEORGE L. WILBER AND TOMMY W. ROGERS

Mississippi State University

AGRICULTURAL EXPERIMENT STATION

HENRY LEVECK, Director

STATE COLLEGE MISSISSIPPI

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Table 1. Interstate migration of the Mississippi population by race, 1890-1960.

	Total			White			Non-White		
	In-migrants	Out-migrants	Difference	In-migrants	Out-migrants	Difference	In-migrants	Out-migrants	Difference
1880	259,231	193,714	65,517	117,192	120,006	— 2,814	142,039	73,708	68,331
1890	210,172	224,678	— 14,506	94,078	142,334	— 48,256	116,032	83,344	32,688
1900	215,109	286,010	— 70,901	99,746	178,945	— 79,199	115,363	107,065	8,298
1910	218,715	350,048	—131,333	112,279	217,173	—104,894	106,436	132,875	— 26,439
1920	183,322	491,948	—308,626	111,921	281,369	—169,448	71,401	210,579	—139,178
1930	206,781	609,636	—403,155	137,644	320,790	—183,146	69,137	288,346	—219,209
1950	225,900	947,275	—721,375	178,940	442,545	—263,805	46,960	504,730	—457,770
1960	266,875	1,227,371	—960,496	226,157	565,123	—338,966	40,718	662,248	—621,530

Interstate Migration of the Mississippi Population, 1960

By GEORGE L. WILBER AND TOMMY W. ROGERS

Introduction

Three components—births, deaths, and migration—determine population change. By experience and tradition citizens of the United States have moved freely across state lines. This freedom of movement has played a tremendously important part in the economic, social and political development of the country. Internal migration has affected all institutions, and is a major element in determining the composition of an area's population.

Information on the state of birth of the population has been gathered at each census since 1850. Although these figures reflect the migration of persons who have moved from one state to another and are, on the date of the census, living in states other than those in which they were born, they do not indicate the total number of persons who have moved from the state in which they were born. Some died before the census was taken and others returned to the state in which they were born. The statistics reflect both the direction and intensity of interstate migration patterns, but it should be remembered that they indicate only the net result of migration at the time of enumeration, and are not measures of all migratory movement.

The purpose of this paper is to survey the interstate migration trends of the Mississippi population with respect to out-migration and in-migration patterns on the basis of state-of-birth statistics.[1]

Long-Term Out-Migration

Table 1 shows the interstate migration of the Mississippi population at census intervals, by race, from 1880 to 1960.

In 1880 there were 259,231 persons living in Mississippi who were born in other states. This figure was 65,517 more than the 193,714 persons born in Mississippi who were living in other states.

Twenty years later the number of people residing in Mississippi who were born in other states had dropped to 215,109 while the number of people living in other states but born in Mississippi had increased to 286,010, giving the state a net loss of 70,901 persons through interstate migration.

This net loss through out-migration increased at each succeeding census to a total of 960,496 in 1960.

Differential migration patterns by race, both as to degree of movement and destination, is one of the outstanding characteristics of the interstate migratory movement of the Mississippi population. Nonwhite out-migration did not gain much momentum until about 1900, with the state recording a loss of nonwhite persons through interstate migration for the first time in 1910. That year there were 106,436 nonwhites who were born in other states living in Mississippi, and 132,875 non-white persons who were born in Mississippi living in other states, an exchange differential of -26,439 persons. Since then the exodus of nonwhites has shown trends that are similar to but which exceed the out-migration of whites.

In 1930 the net loss of nonwhites through the exchange of migrants with

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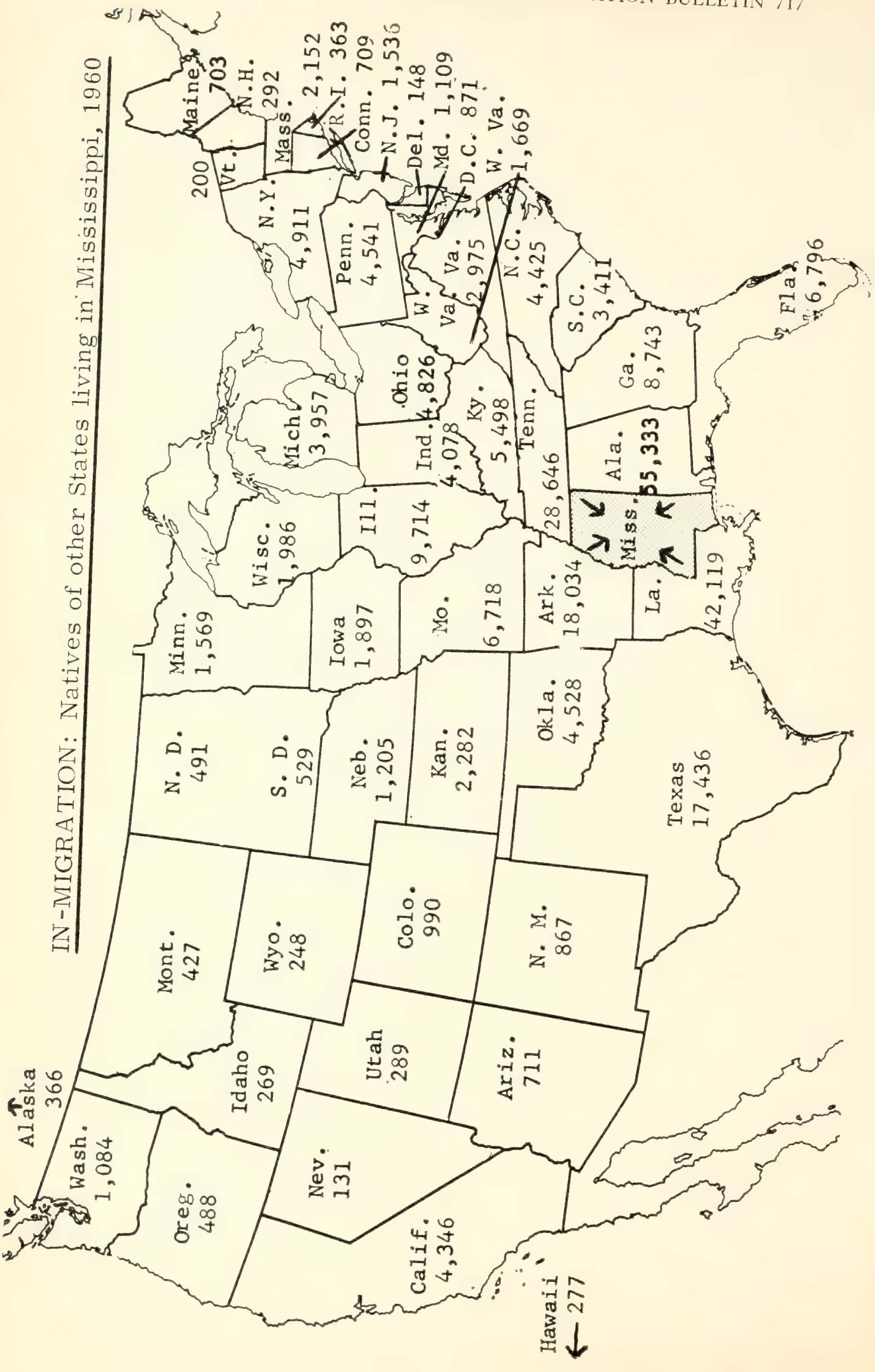
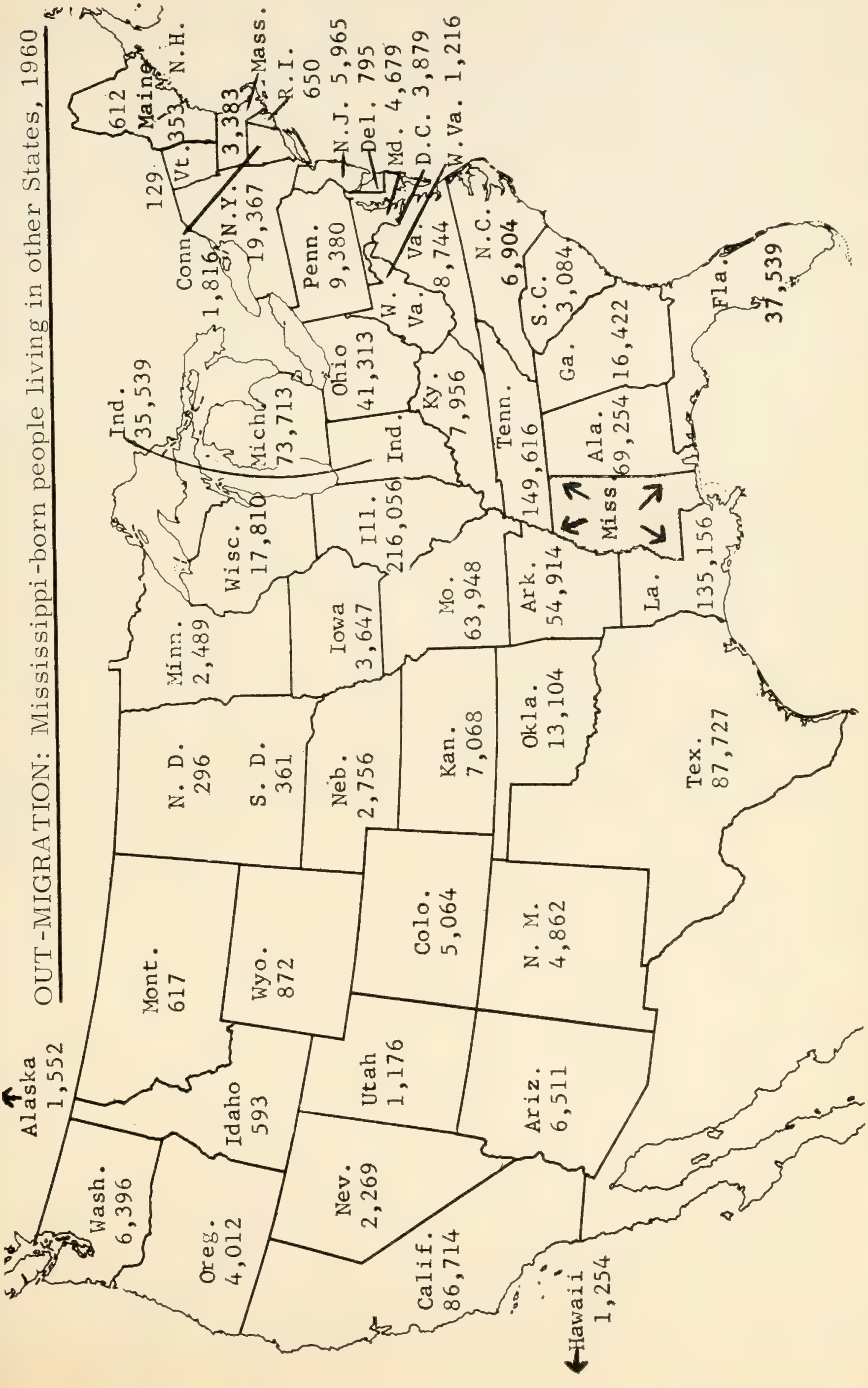
[1] For further discussion of state of birth statistics, see U. S. Bureau of the Census, **U. S. Census of Population: 1960 Subject Reports State of Birth.** Final Report AC(2) -2A. U. S. Government Printing Office, Washington, D. C., 1963.

IN-MIGRATION: Natives of other States living in Mississippi, 1960


Maine 703
N.H. 292
Vt. 200
Mass. 2,152
R.I. 363
Conn. 709
N.J. 1,536
Del. 148
Md. 1,109
D.C. 871
W. Va. 1,669
N.Y. 4,911
Penn. 4,541
Va. 2,975
N.C. 4,425
S.C. 3,411
Ga. 8,743
Fla. 6,796
Ohio 4,826
Mich. 3,957
Ind. 4,078
Ky. 5,498
Tenn. 28,646
Ala. 35,333
Miss.
Ill. 9,714
Wisc. 1,986
Minn. 1,569
Iowa 1,897
Mo. 6,718
Ark. 18,034
La. 42,119
Okla. 4,528
Texas 17,436
N. D. 491
S. D. 529
Neb. 1,205
Kan. 2,282
Mont. 427
Wyo. 248
Colo. 990
N. M. 867
Idaho 269
Utah 289
Ariz. 711
Wash. 1,084
Oreg. 488
Nev. 131
Calif. 4,346
Alaska 366
Hawaii 277



OUT-MIGRATION: Mississippi-born people living in other States, 1960

Alaska 1,552
Wash. 6,396
Oreg. 4,012
Calif. 86,714
Hawaii 1,254
Idaho 593
Nev. 2,269
Mont. 617
Wyo. 872
Utah 1,176
Ariz. 6,511
Colo. 5,064
N. M. 4,862
N. D. 296
S. D. 361
Neb. 2,756
Kan. 7,068
Okla. 13,104
Tex. 87,727
Minn. 2,489
Iowa 3,647
Mo. 63,948
Ark. 54,914
La. 135,156
Wisc. 17,810
Ill. 216,056
Ind. 35,539
Ind.
Mich. 73,713
Ohio 41,313
Ky. 7,956
Tenn. 149,616
Miss.
Ala. 69,254
Ga. 16,422
Fla. 37,539
S.C. 3,084
N.C. 6,904
W. Va.
Va. 8,744
Penn. 9,380
N.Y. 19,367
Conn. 1,816
612 Maine
129 Vt.
353 N.H.
3,383 Mass.
R.I. 650
N.J. 5,965
Del. 795
Md. 4,679
D.C. 3,879
W.Va. 1,216

other states exceeded that of the whites for the first time. By 1960, the net nonwhite loss (621,530) exceeded the net loss of whites (338,966) by 282,564 persons.

Out-Migration During the 1950's

The out-migration pattern of the Mississippi population during the 1950's was similar to the long term trends. There were 280,096 more persons born in Mississippi residing in other states in 1960 than there were in 1950. The figures for whites and nonwhites were nearly 123,000 and 158,000, respectively.

Table 2 shows the number of Mississippi out-migrants and in-migrants, by race, for the four major census regions of the United States. For the total population, the ratio is two out-migrants for every one moving into Mississippi from another state. For the North Central and Western regions the ratio is 12 to 1. The ratio of out-migrants to in-migrants for whites is much smaller in every region than for nonwhites. The out-migration ratio for nonwhites is highest in the North central (90 out-migrants for every one in-migrant) and Western regions (96 out-migrants for every one in-migrant). The out-migration ratio for whites is highest in the West (five out-migrants for every one in-migrant) and South (two and one-half out-migrants for every one in-migrant, or 15 out-migrants for every 10 in-migrants).

Of the 3,108,296 persons living in the United States in 1960 who were born in Mississippi, 1,227,371 or 39.5 percent were living in other states. The number of whites born in Mississippi but living in other states (565,123) was 45 percent of the state's total white population in 1960. The number of nonwhites born in Mississippi but living in other states (662,248) was 72.0 percent of state's nonwhite population in 1960.

Short-Distance Out-Migration

Nearly one-half of the Mississippi born population living in other states in 1960

Table 2. Ratio of out-migrants to in-migrants by regions, Mississippi, 1960.

Region	Number In-migrants	Number Out-migrants	Net exchange	Ratio of Out- to In-migrants
		Whites		
United States	226,157	565,123	—338,966	2.5
Northeast	14,698	16,243	— 1,545	1.1
North Central	34,877	66,787	— 31,910	1.9
South	166,672	415,995	—249,323	2.5
West	9,910	66,098	— 56,188	6.6
		Non-Whites		
United States	40,718	662,248	—621,530	16.3
Northeast	709	25,412	— 24,703	35.8
North Central	4,357	398,236	—393,879	90.4
South	35,069	182,806	—147,737	5.2
West	583	55,794	— 55,211	95.7
		Total Population		
United States	266,875	1,227,371	—960,496	4.6
Northeast	15,407	41,655	— 26,248	2.7
North Central	39,234	465,023	—425,789	11.8
South	201,741	598,801	—397,060	2.9
West	10,493	121,892	—111,399	11.6

Source, Table II-IX: U. S. Bureau of the Census. **U. S. Census of Population: 1960. Subjec Reports. State of Birth.** Final Report PC(2) -2A. U. S. Government Printing Office, Washington D. C., 1963.

remained in the South (48.8 percent), with a substantial proportion of this number (68.3 percent) residing in the contiguous states of Tennessee, Arkansas, Alabama, and Louisiana. The 408,940 Mississippi-born residents of these four states account for one-third of all out-migrants from the state.

Of the state's 276,220 white male out-migrants, 200,712 (72.7 percent) remained in the South. Of the 288,903 white female out-migrants, 215,283 (74.5 percent) remained in the South. On the other hand, only 88,704 (27.8 percent) of the nonwhite male out-migrants and 94,102 (27.4 percent) of the nonwhite female out-migrants remained in the South. As a whole, 48.8 percent of those persons who were born in Mississippi but were residing in other states in 1960 had remained in the South.

Long-Distance Out-Migration

Whereas the bulk of white out-migration has been to other Southern states, the greatest part of nonwhite out-migration has been to the North Central region. Of the 662,248 nonwhite out-migrants, 398,236 (60.1 percent) were living in the North Central region. This compares with 56,787 (10 percent) of the 565,123 white out-migrants living in the North Central region.

In fact, there were more nonwhites born in Mississippi and living in Illinois, which is in the North Central region, than in all the states of the census South, excluding Mississippi. Due to this heavy influx of nonwhite out-migrants Illinois contained more out-migrants from Mississippi (216,056) than any other state. Of this number, 193,118 (89.4 percent) were nonwhites. Of the western states, California had the largest number of both white and nonwhite out-migrants.

In-Migrants

A phenomenal difference is also found in the racial composition of the migrants coming into the state. The 1960 census showed about 2.5 white persons born in Mississippi residing in other states for every white born in other states living in Mississippi. About 16 Mississippi-born nonwhites were residing in other states for every nonwhite born in other states but living in Mississippi.

A total of 266,875 persons, or 12.3 percent of Mississippi's total population in 1960, were in-migrants who were born in other states. The 117,187 white male in-migrants composed 18.9 percent of the total white male population, while the 108,969 white females living in Mississippi who were born in other states comprised 17.3 percent of the state's 1960 white female population. Of the total 226,156 white in-migrants, 166,672 (73.8 percent) were from the South, and 34,877 (15.4 percent) were from the North Central region.

The number of nonwhite in-migrants was considerably smaller, both proportionately and numerically, than was the case for white in-migrants. Although the absolute number of white in-migrants has increased at each census since 1920, the absolute number of nonwhite in-migrants has decreased at each census since 1900. Most of the state's 40,718 nonwhite in-migrants, 35,069, (or 86.1 percent) were from other Southern states. Only 4.5 percent of Mississippi's 1960 nonwhite male population and 4.3 percent of the nonwhite female population were in-migrants from other states.

Non-Migrants

Of the 3,108,296 persons living in the United States in 1960 who were born in Mississippi, 1,880,925 (60.5 percent) were still living in Mississippi. These comprised 86.7 percent of the state' total population.

Of the 773,221 white males in the United States in 1960 who were born in

Mississippi, 497,001 (64.3 percent), or 79.9 percent of the total white male population, had remained in the state. Of the 801,150 white females in the United States in 1960 who were born in Mississippi, 512,247 (63.9 percent) had remained in the state. This constituted 81.5 percent of the total white female population of the state in 1960.

Due to the fewer number of nonwhite in-migrants, a larger percentage of Mississippi's whites than nonwhites were born in the state. Of the 738,009 nonwhite males in the United States who were born in Mississippi, 419,045 (55.8 percent) were still living in Mississippi. Of the 795,916 nonwhite females in the United States who were born in Mississippi, 452, 623 (56.8 percent) had remained in the state. However, these nonwhite non-migrants who had remained in the state comprised 94.8 percent of the 1960 nonwhite population.

Summary

For whites, both male and female, the greatest concentration of out-migrants from Mississippi is found in the contiguous states plus Texas and California

For nonwhites the state of Illinois contains the greatest concentration of out-migrants from Mississippi. In fact, more nonwhites who were born in Mississippi were living in Illinois in 1960 than were living in all the Southern states—excluding Mississippi—and the District of Columbia combined. Other states in the North Central region, Ohio, Indiana, Michigan, and Missouri, and California in the West, contained large numbers of nonwhite out-migrants from Mississippi.

The greater part of the in-migrants to Mississippi from other states, for both white and nonwhite, were from other Southern states. In-migrants to Mississippi from other states accounted for much higher proportions of the 1960 total white male and female populations than they did for the nonwhite male and female populations.

The differential migration rates between the white and non-white population groups, which has been characteristic of the state since about 1910, continued through the 1950-1960 decade. At the same time, the absolute number of nonwhite in-migrants continued to decline, whereas there was an increase in the absolute number of white in-migrants.

BULLETIN 718 NOVEMBER 1965

Chemical Control Of Corn Earworm In Large Plantings Of Sweet Corn

Mississippi State University
AGRICULTURAL EXPERIMENT STATION
HENRY LEVECK, Director
STATE COLLEGE MISSISSIPPI

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Chemical Control of Corn Earworm in Large Plantings of Sweet Corn, State College, Mississippi

BY W. A. DOUGLAS AND E. L. MOORE[1]

During and immediately after World War II, sweet corn was produced in the Hattiesburg, Greenville, and Batesville, Mississippi areas. The sweet corn from these areas was marketed on a "clip corn" basis and sold primarily to Army camps during the war. After the war, cooperatives were formed and the sweet corn was sold locally as well as at distant markets. The acreage planted to sweet corn on individual farms was small, seldom over 5 acres.

By 1951, all distant and most local markets demanded nonclipped corn, but farmers were not producing worm-free corn and thus could not sell their product. By 1955, Mississippi producers were virtually out of the sweet corn business. At that time the Agricultural Economics and Horticultural departments of Mississippi State University began their investigation of the number of growers who followed the cultural and chemical control practices recommended by the Mississippi Agricultural Experiment Station. Their investigations revealed that damage by the corn earworm [**Heliothis zea** Boddie] was a primary reason for the rejection of Mississippi grown sweet corn. None of the acreage in the study had received the recommended insecticide program. Only 4 percent of the acreage had received the minimal spray program with 60 percent receiving only three applications of an insecticide.

In small plots at State College, Mississippi, and Tifton, Georgia, many new chemicals, applied with hand sprayers, have been tested for earworm control. In order to evaluate the more superior chemicals on a semicommercial basis and to demonstrate their effectiveness when properly applied, large-scale experiments were established at State College. In this program were tested only those chemicals that had provided the most effective earworm control in small plots at Tifton or State College. Results of the large-scale tests are recorded here.

Materials and Methods

The 1960 tests involved two sweet corn hybrids—Seneca Chief and Golden Security In 1961 the tests included a third hybrid—Royal Gold. These hybrids were selected mainly because of their differences in foliage density.

Seneca Chief represents a type with dense foliage and many flag leaves. Thus satisfactory spray coverage of this variety is difficult. On the other hand, Golden Security represents a type with moderate foliage and few flag leaves. It is therefore easy to obtain coverage of this hybrid. Royal Gold, similar in many respects to Golden Security, has large ears and almost no flag leaves; so for it, too, coverage is easy.

In addition these hybrids were selected because they possess one or more desirable horticultural characteristics. Seneca Chief gives fairly high yield, produces high quality corn, and in this area retains top quality at maturity over a period of 4 to 5 days. Golden Security is prolific. Few other hybrids approach its yield in number of ears per acre. The ears are well shaped, of moderate quality, and very short. Of its total weight an ear of Golden Security yields about 32 percent in cut corn. It loses top quality in about 30 hours. Royal Gold produces very well. The ears are large, long, well-shaped, and well-suited to the Mississip-

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[1] W. A. Douglas, Entomologist, Agricultural Research Service, Entomology Research Division, State College, Mississippi. E. L. Moore, Horticulturist, Mississippi Agricultural Experiment Station, State College, Mississippi.

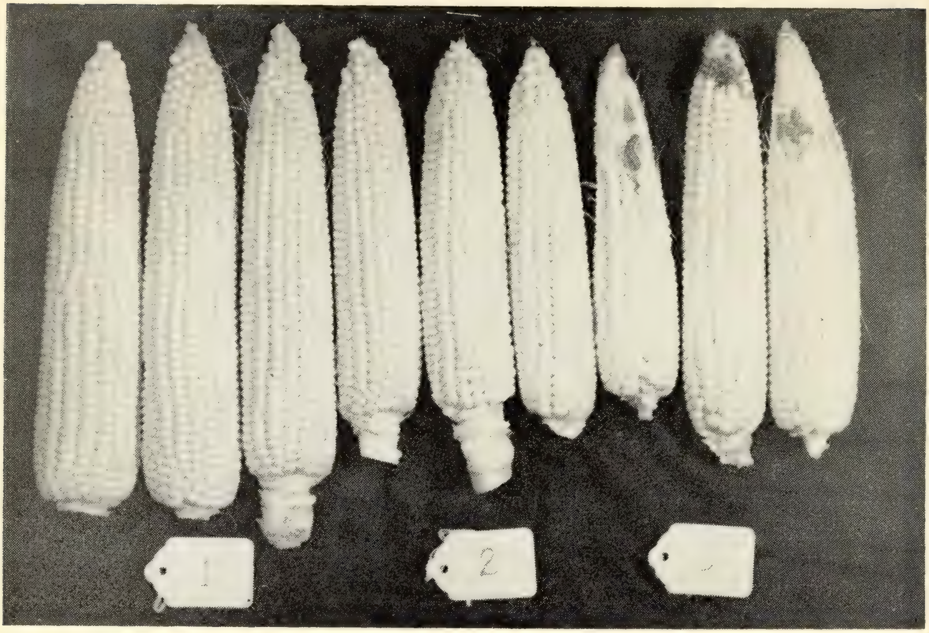

Figure 1. Chemical sprays effectively controlled corn earworms in two sweet corn hybrids. No. 1—Royal Gold (three ears on the left) and No. 2—Golden Security (three center ears), were sprayed daily to within four days of harvest. No. 3—the nonsprayed Golden Security check.

pi market. The yield of cut corn is about 28 percent, but because of the large ear size, the amount of cut corn per acre of Royal Gold approximates that of Golden Security. The ability of Royal Gold to retain top quality at harvest is poor.

In general the block size of the test plantings was 16 rows wide and 300 feet long for each hybrid tested. The 16 rows were divided into 4 four-row plots, the minimum plot size for a chemical treatment. Alleys were provided at the end of the plots for turning the equipment. Treatment plots were randomized and replicated 4 times. Samplings for analysis of data were taken at random from the two center rows of a plot. The data reported represent the average of four replicates.

The first planting in 1960 was made on April 15, the second on May 15, and the third on July 9. The different planting dates were used to capitalize on the variation in the corn earworm infestation as the season progressed. Usually the heaviest infestations occur in the early and late plantings. Infestations in mid-season plantings are usually moderate.

The chemicals were applied with a 4-row high clearance sprayer at a pressure of at least 100 p.s.i. The nozzles were arranged so that each one directed a spray stream toward the silks. Four 65° and 80° fan-type nozzles were employed per row and set to thoroughly cover a 30-inch band. The 30-inch band was necessary to compensate for the variation in ear height on various stalks. Number 65001 or 8001 Tee Jet nozzles were used with a pressure of 100 to 120 p.s.i. and the spray rig, traveling at a speed of 3 miles per hour, delivered 25 gallons of spray per acre. The timing and number of applications were varied among the treatments as listed in the tables.

Table 1. Results of tests to control the corn earworm on two varieties of sweet corn treated with DDT mechanically sprayed at different times beginning 5 days after first silk emergence. Corn planted April 15, 1960.

Hybrid	Time of application	No. of applications	Percent worm free	Percent* control
Seneca Chief	Daily	11	70	70
	Every other day	6	63	63
	Every 3rd day	4	26	26
	Check plot	None	0	0
Golden Security	Daily	11	78	78
	Every other day	6	65	65
	Every 3rd day	4	47	47
	Check plot	None	0	0

*Percent control calculated by Abbott's formula: [Modified by members of Maryland Agr. Expt. Sta. See J. of Wash. Aad. Sci. 55, 1-5 (1965)].

$\frac{x-y}{x}$ x 100 = percent control, where

x = percent living in check. y = percent living in treated plot.

Table 2. Results of tests to control the corn earworm on two varieties of sweet corn treated with two different insecticides mechanically sprayed several times, beginning on the day or 1 day before silk emerged. Corn planted on May 15, 1960.

Hybrid	Material	Number of applications	Time of application	Type of nozzle	Percent worm free	Percent control*
Seneca Chief	DDT	11	Daily	Cone	96	90
		11	"	Fan	100	100
		6	Every other day	Cone	100	100
		6	"	Fan	95	88
		4	Every 3rd day	Cone	100	100
		4	"	Fan	98	95
	Carbaryl	6	Every other day	Cone	98	95
		6	"	Fan	100	100
	Check	None	------------	------	58	------
Golden Security	DDT	11	Daily	Cone	100	100
		11	"	Fan	100	100
		6	Every other day	Cone	98	95
		6	"	Fan	97	92
		4	Every 3rd day	Cone	97	92
		4	"	Fan	90	73
	Carbaryl	6	Every other day	Cone	97	92
		6	"	Fan	100	100
	Check	---	------------		37	----

*Percent control calculated by modified version of Abbott's formula.

Table 3. Results of tests to control the corn earworm on two different varieties of sweet corn treated with two different insecticides mechanically sprayed several times beginning on the day first silks emerged. Corn planted on July 9, 1960.

Hybrid	Material	Number of applications	Time of application	Percent worm free	Percent control*
Seneca Chief	DDT	8	Daily	54—	54
		5	Every other day	14	14
		4	Every 3rd day	17	17
	Carbaryl	8	Daily	62	62
	Check	None	------	0	0
Golden Security	DDT	8	Daily	77	77
		5	Every other day	47	47
		4	Every 3rd day	25	25
	Check	None		0	0

*Percent control calculated by modified version of Abbott's formula.

Twenty-five ears in each replicate were examined as soon as they reached the early dough stage. The ears were husked and the amount of feeding on each infested ear was measured. Data in the "percent worm free" column was calculated from these records.

1960 Tests

Two hybrids and two chemicals were tested. Golden Security and Seneca Chief were planted on April 15, May 15 and July 9. The chemicals applied were DDT, 25% emulsifiable concentrate at 2 pounds per acre per application in all three plantings and Carbaryl, 85% sprayable at 1 ¼ pounds per acre per application in the May 15 and July 9 plantings In the May 15 planting cone and fan-type nozzles were compared. The frequency and number of applications of each insecticide and the results are shown in Tables 1, 2, and 3.

The first daily spray application was delayed until 5 days after first silk emergence in the April 15 planting because of mechanical trouble with the spray equipment. This delay allowed the earworm moth to oviposit for 5 days on untreated silks and probably accounted for the poor control obtained from all treatments. as shown in Table 1. The infestation was 100% in both hybrids. Results from these tests emphasized that with high moth populations present, satisfactory control is not obtained when the spray schedule is initiated after the silks emerge from the ears. Applying DDT on every third day was of little value since it gave only 26 percent control in Seneca Chief and 47 percent in Golden Security The most satisfactory degree of control was obtained from 11 daily applications of DDT which gave 70 percent control in Seneca Chief and 78 percent in Golden Security.

In the May 15 planting the first sprays were applied on the day or day before the silks emerged. The planting came into silk at a time when moth population was moderately light and the resulting infestation was only 42 percent in Seneca Chief and 63 percent in Golden Security Table 2 shows that under these conditions both insecticides gave a high percentage of worm free ears and no differences in efficiency were observed between flat fan and cone shaped nozzles Slight husk and leaf damage was noted in corn sprayed daily with DDT, but no damage was observed on corn sprayed daily with Carbaryl.

In the July 9 planting spray treatments were started on the day the first silks appeared August 26 and continued through September 3. The results are shown in Table 3. The check plots in this test were 100% infested and almost completely devoured by corn earworms which provided a very severe test of the insecticides. Infestation was so severe in the tassels, stalks and ears that poor pollination occurred and none of the ears were marketable.

Under these conditions of heavy infestation, daily applications of DDT gave only 54 percent control in Seneca Chief and 77 percent in Golden Security while daily applications of Carbaryl gave 62 percent control in Seneca Chief.

1961 Tests

All three hybrids were planted April 17, May 18, and June 27. Carbaryl (80% sprayable), 1 ¼ pounds per acre per application, and DDT (25% emulsifiable concentrate), 2 pounds per acre per application, were applied in the tests. The materials, number and time of applications, percentage of worm-free ears and percentage of control for the three plantings are presented in Table 4. The results in Table 4 show conclusively that insecticides must be applied throughout the silking period for satisfactory earworm control. Daily applications of DDT beginning with first silk appearance and continuing up to 4 days before harvest gave 92% control in each variety. Applying Carbaryl daily, every other

Table 4. **Results of tests to control the corn earworm in three varieties of sweet corn treated with two different insecticides mechanically sprayed several times beginning at different silking stages, 1961.**

Hybrid	Material	Number of applications	Time of application	Percent worm-free	Percent control*
Planted April 17, 1961					
Seneca	DDT	15	Daily beginning with first silks	92	92
Chief	Carbaryl		Daily first 7 days after silking	6	6
		3	Every other day after silks emerged	10	10
		3	Every 3rd day after silks emerged	4	4
	Check	None	....	0	—
Royal	DDT	11	Daily	92	92
Gold	Carbaryl	4	Daily first 4 days after silking	4	2
		3	Every other day	0	0
		2	Every 3rd day	10	1
	Check	None	....	2	—
Golden	DDT	10	Daily	92	92
Security	Carbaryl	1	First day after silking	2	2
	Check	None	....	0	—
Planted May 18, 1961					
Seneca	Carbaryl	13	Daily beginning with first silks	94	92
Chief		5	Every third day after first silks	76	69
	DDT	5	Every third day after first silks	76	69
	Check	None	....	22	—
Royal	Carbaryl	11	Daily beginning with first silks	98	97
Gold		4	Every third day	94	92
	DDT	4	Every third day	92	89
	Check	None	....	28	—
Golden	Carbaryl	11	Daily beginning with first silks	9	93
Security		4	Every third day	96	94
	DDT	4	Every third day	98	97
	Check	None	....	38	—
Planted June 27, 1961					
Seneca	Carbaryl	14	Daily beginning with first silks	98	98
Chief		5	Every third day	78	78
	DDT	5	Every third day	20	20
	Check	None	....	0	—
Royal	Carbaryl	14	Daily beginning with first silks	98	98
Gold		5	Every third day	78	78
	DDT	5	Every third day	74	74
	Check	None	....	0	—
Golden	Carbaryl	14	Daily beginning with first silks	100	100
Security		5	Every third day	96	96
	DDT	5	Every third day	78	78
	Check	None		0	

*Percent control calculated by modified version of Abbott's formula.

day, or every third day during the first half of the silking period gave 10 percent or less control. Spraying plants during the first 7 days of the silking period apparently left later silk growth free of insecticides and thus attractive for moth oviposition. At the time damage was recorded, the larvae had developed on the unsprayed portion of the silks in a normal manner.

The corn earworm infestation was light in the May 18 planting. The percentage of worm-free ears in the check treatments was 22 in Seneca Chief, 28 in Royal Gold, and 38 in Golden Security (Table 4). Daily applications of Carbaryl throughout the silking period gave 92 percent control in Seneca Chief, 100 in Royal Gold, and 97 in Golden Security. Applying Carbaryl every third day gave 82 percent earworm control in Seneca Chief, and 92 percent in Royal Gold and Golden Security. DDT applied every third day gave 69 percent control in Seneca Chief, 89 in Royal Gold, and 97 in Golden Security.

The corn earworm infestation was very heavy in the June 27 planting with all three hybrids having a 100% infestation. Carbaryl applied daily throughout the silking period gave 98 percent control in Seneca Chief and Royal Gold and 100 percent in Golden Security. When applied every third day, this material gave 78 percent control in Seneca Chief and Royal Gold and 96 percent in Golden Security. The degree of control from DDT applied every third day was 20 percent in Seneca Chief, 74 in Royal Gold, and 78 in Golden Security.

Summary and Conclusions

Results of all tests indicate that spray applications must be made from the appearance of the first silk up to four days of harvest to obtain effective earworm control.

Carbaryl is recommended for earworm control on sweet corn because it gave equally satisfactory control and does not present the residue hazard of DDT.

The degree of control depends on the level of infestation and number of spray applications. Under conditions of light infestations (40-60%) the application should be made every third day. When the infestations are moderate (60-80%) the application should be made every other day. Heavy infestations (80-100%) require daily applications.

The spray may be applied with either a cone or fan type nozzle. The nozzle size should be determined by the formulation of the material, pressure and tractor speed. Four nozzles should deliver the chemical at 1 ¼ pounds actual per acre per application.

Earworm control was more easily accomplished in Golden Security and Royal Gold than in Seneca Chief. Dense foliage in Seneca Chief made spray coverage of the silks difficult.

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The Place Of Cow-Calf Enterprises In Farming Systems In The Yazoo-Mississippi Delta

Mississippi State University

AGRICULTURAL EXPERIMENT STATION

HENRY LEVECK, Director

STATE COLLEGE MISSISSIPPI

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THE PLACE OF COW-CALF ENTERPRISES IN FARMING SYSTEMS IN THE YAZOO-MISSISSIPPI DELTA

BY ARTHUR M. HEAGLER, FRED T. COOKE, JR.,[1] AND
THOMAS E. TRAMEL[2]

Introduction

The Yazoo-Mississippi Delta is an intensive and highly specialized farming area lying south of DeSoto and north of Warren Counties, Mississippi, and flanked on the west by the Mississippi River and the Loess deposits of the hills on the east.

The area contains slightly over 4 million acres of land and 81 percent of it is utilized by agriculture. Farms contain slightly over 2 million acres of cropland, 454,000 acres of woods, 508,000 acres of pasture and levee, and 174,000 acres of other land.[3]

Cotton is the major crop, producing approximately 80 percent of all farm gross sales, followed by soybeans, beef cattle, rice, and small grains.

Interest in beef cattle as an alternative enterprise began when cotton acreage controls reduced the acreage of this crop, and farmers had little success with several alternative row crops. Beef numbers increased rapidly, from 88,300 head in 1950 to a peak of 228,000 head in 1957.

Beef numbers declined in 1957 and 1958 as farmers, because of poor crops, were forced to sell breeding stock to meet current expenses usually paid by row-crop enterprises. This trend continued as new high-yielding soybean varieties became available and farmers accepted new soybean cultural practices. As soybean yields and prices increased, pasture land moved back into row crops and beef numbers continued to decline.

In 1960 beef numbers again began to increase. Currently there are 206,000 head of beef animals on Delta farms, representing an increase of 123 percent over 1950.[4]

Thus, the initial expansion of beef numbers indicated the decision many farmers reached in selecting among alternative enterprises to utilize the cropland made available by Government restriction of cotton acreage.

The current expansion in beef numbers reflects the ability of farmers to adjust the sod-crop mix within their farm organization, and through use of complete or partial substitution of one forage species for another, increasing herd size with no increase in pasture acreage.

A three-phase study was undertaken in 1955 to provide (1) a general description of beef cattle enterprises as they were found on Delta farms. This included beef enterprise input-output data, land use, cropland organization, and forage crop production practices; (2) detailed pasture input-output data for the most common sod crops produced in the area; and (3) an evaluation of the beef cattle enterprise to determine its place in Delta farming systems and determine how the enterprise might fit into existing cropping patterns through fuller use of under-used resources or byproducts of the cropping system.

This report deals with the third phase of this study. Its main objectives are:

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[2] Professor, Department of Agricultural Economics, Mississippi State University, State College, Miss.

[3] "Statistical Digest of Resources and Economic Activity, Economic Area I, Delta." Statis. Ser. No. 84, Miss. State Univ., Oct. 1962.

[4] "Mississippi Agricultural Statistics — Supplement No. 5." Jan. 1963.

(1) to determine if a cow-calf enterprise will profitably fit into existing farm organizations and cropping patterns, (2) to determine optimum crop-livestock organizations for each year during the transition from the present to optimum farm organizations, and (3) to determine the time requirements for this adjustment within a framework of practical and economic feasibility.

Sources of Data

The five typical farms or situations used in this report were developed from information obtained in phase one of this study. This study pointed out that farmers with less than 300 acres of cropland and/or 500 acres of total land seldom had commercial cow-calf enterprises included in the farm organization.[5] These farms did not have a sufficient amount of unused land or open land unsuitable for crops to support a minimum size cow-calf enterprise.

The distribution of soil within each resource situation is based on data obtained from the Delta phase of Regional Project S-42.[6]

The following four broad soil classifications were used to make the distribution of soils within each resource situation (sandy, loam, clay 1, and clay 2). Each classification contains soils with similar physical characteristics requiring similar cultural practices and with like yields.[7]

The clay 2 soils classification was added to determine if marginal cropland, soils with a yield potential of not more than 18 bushels of soybeans per acre, should be in pasture or in row crops.

Row-crop budgets were developed using the latest information available on yield and production practices.[8] Pasture input-output data were obtained from phase 2 of this study and represent yield levels attained under farm conditions.[9]

The technique of linear programming was used to obtain optimum crop-livestock organizations for each of the five typical size-resource situations studied.

It should be recognized that many Delta farms, due to either size or soils distribution, do not have sufficient pasture land available to maintain a nominal size cow-calf enterprise. It is estimated that 86 percent of the total pasture resources of the area will fit into one of the five resource situations included in this report.

Initial Crop-Livestock Organizations

Detailed information on land use, soils distribution, and crop livestock organizations for each of the five resource situations are shown in tables 1 and 2.

The sandy farm situations differ greatly in total size. However, the distribution of soils by physical characteristics and land use are almost identical when viewed as a percentage of the total resources.

The same is not true for the clay farms. Approximately 63 percent of the small clay farms total land resource was

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[5] "The Economics of Beef Cattle Production in the Yazoo-Mississippi Delta," A. M. Heagler, F. T. Cooke, Jr., and G. B. Crowe, Miss. Agr. Expt. Sta. Bul. 631, Nov. 1961.

[6] "Budgets for Major Farm Enterprises in the Mississippi River Delta of Arkansas, Louisiana, and Mississippi," Miss. Agr. Expt. Sta. Bul. AEc. M.R. 30, June 1961.

[7] "Normal Yields and Production Practices by Soil Mapping Units, Delta Area of Mississippi," T. E. Tramel, W. E. Keenan, and H. B. Vanderford, Miss. Agr. Expt. Sta. Bul. 629, Oct. 1961.

[8] Ibid footnotes 4 and 5.

[9] "The Economics of Pasture Yields in Beef Cattle Production, Yazoo-Mississippi Delta," A. M. Heagler, G. B. Crowe, and F. T. Cooke, Jr., Miss. Agr. Expt. Sta. Bul. 649, Sept. 1962.

Table 1. Soils distribution and present land use, 5 typical crop-livestock resource situations, Yazoo-Mississippi Delta.

	Resource situation				
	Small		Large		
Item	Sand	Clay	Sand	Clay	Levee[1]
	Acres	Acres	Acres	Acres	Acres
Total land	820	688	2,500	2,420	1,862
Sand	293	0	895	0	566
Loam	120	35	364	108	231
Clay 1	59	374	199	1,175	121
Clay 2					
Cropland	20	22	42	37	32
Pasture	107	23	326	79	233
Land in crops	492	431	1,500	1,320	950
Pasture land	149	202	454	714	601
Total pasture	256	225	780	793	834
Woods	72	32	220	307	78

[1]This situation represents farms located adjacent to the Mississippi River levee. Grazing rights on the levee, subject to certain restrictions, are often an integral part of the operation and afford a relatively cheap source of forage.

Table 2. Present cropland organization by crop, and soil type, and pasture land by sod crop, 5 typical resource situations. Yazoo-Mississippi Delta.

		Resource situation				
		Small		Large		
Item	Unit	Sand	Clay	Sand	Clay	Levee[1]
Cotton						
Sand	Acre	200	0	534	0	338
Loam	Acre	0	35	0	108	0
Clay	Acre	0	139	0	362	0
Corn						
Sand	Acre	23	0	108	0	68
Clay	Acre	0	20	0	95	0
Oats						
Sand	Acre	70	0	253	0	160
Loam	Acre	15	0	60	0	68
Clay	Acre	0	74	0	276	0
Soybeans						
Loam	Acre	105	0	251	0	163
Clay	Acre	42	127	241	433	120
After oats	Acre	20	18	42	37	32
Idle	Acre	37	36	53	46	33
Fescue	Acre	122	108	369	374	367
Levee	Acre	0	0	0	0	279
Common bermuda	Acre	55	48	170	174	0
Dallis	Acre	54	47	165	168	108
Johnson grass	Acre	25	22	76	77	80
Beef[2]	Number	91	79	190	193	219
Farm income[3]	Dollar	21,151	7,523	57,559	20,733	34,208

[1]See footnote 1, table 1.

[2]Number of mature brood cows.

[3]Returns to land, management, and overhead.

being utilized as cropland. The large clay farms had less total land in crops (55 percent) and more in woods (13 percent). There is little difference in the portion of total soil resources utilized as pasture land in either situation. However, the percentage of marginal cropland or clay 2 soils and land suitable only for pasture is higher in the small clay resource situations.

In every resource situation over half of the total land was used as cropland, and at least 30 percent was utilized as pasture. Wasteland and woods ranged from 4 percent of the total land on the levee farms to almost 13 percent on the large clay farm.

The crop-livestock organizations shown in table 2 represent cropping patterns presently existing throughout the area. Generally, cropping patterns tend to be similar, regardless of resource situation, size, or soil distribution. Enterprise selection is restricted primarily to cotton, corn, small grains, soybeans, and livestock. The first three enterprises compete directly for the sandy and loam portion of the cropland resource while the latter two compete for the clay resource. In some cases, soybeans compete with corn and small grains for the mixed or loam soil resource.

The allocation of the cropland resource among row-crop enterprises is identical for both small resource situations. Cotton occupies 40.5 percent of the land in crops followed by soybeans 29.75 percent, oats 17 percent, corn 4.5 percent, and idle cropland 8 percent. The large sand and clay situations had 35 percent of the cropland in crops planted in cotton, 32.75 percent in soybeans, 20 percent in oats, and 7.5 percent in corn. Idle land accounted for 4 percent of the total land in crops.

The levee situation had 35.5 percent of the cropland in cotton, 30 percent in soybeans, 24 percent in oats, and 7 percent in corn. Only 3.5 percent of the cropland was idle.

Permanent sod crops were grown on marginal cropland (clay 2 soils) on all resource situations. This is of major importance on the sandy farms as 42 percent of the pasture acreage occupied marginal cropland. About 28 percent of the pasture found on the levee farm and 10 percent of the pasture on the clay farms were on marginal cropland.

The clay and levee farms contain considerable land that is unsuitable for any agronomic use other than pasture (approximately 30 percent of the total farm acreage) while the sandy farms have less than 19 percent of the total land resources that has no use other than for pasture.

Present sod crop organizations are also presented in table 2. Fescue is the main sod crop utilizing from 44 to 48 percent of the total pasture acreage. Common Bermuda and Dallis grass are of equal importance utilizing 22 and 21 percent, respectively, of the total pasture on all but the levee farm where common Bermuda utilizes 33 percent and Dallis 13 percent of the pasture acreage. Johnson grass occupies 10 percent of the total pasture resource in each situation.

An earlier study indicated that stocking rates are directly related to the size of the resource situation.[10] Small farms utilize high stocking rates in an effort to maintain a beef unit of sufficient size on a restricted physical resource base. As the resource situation increases in size, stocking rates tend to decrease as indicated in table 2.

The cropland organization within each farm resource situation is usually dictated by the physical distribution of soils within the situation. Thus, income differences between similar size farms are more closely related to differences in cropland organization than to cropping pattern. Adjustment opportunities are greater on both of the sandy and levee farms since the soil resource is not as restricted in use as that found on clay farms.

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[10] "The Economics of Beef Cattle Production in the Yazoo-Mississippi Delta," A. M. Heagler F. T. Cooke, Jr., and G. B. Crowe, Miss. Agr. Expt. Sta. Bul. 631, Nov. 1961

Optimum Crop-Livestock Organizations

Optimum land use patterns and crop-livestock organizations were obtained for each resource situation. Changes in land use (table 3) were minor. Marginal cropland (clay 2 soils) moved out of cropland and into permanent sod crops. Considerable adjustment in the crop-livestock organization and cropping pattern occurred in every resource situation. Optimum crop-livestock organizations for the five typical farms included in the analysis are presented in table 4.

Cotton continued to utilize a major portion of the better cropland just as it did in the organizations before adjustment. Soybeans became a major enterprise on the clay farms replacing both corn and oats in the cropping pattern. Oats increased in importance on the sandy and levee farms replacing all of the corn and a portion of the soybeans grown on sand and loam soils. High grain yields associated with the supplemental grazing obtained from oats grown on sand and loam soils coupled with some other economies of operation permit oats to compete with corn and soybeans.

Drastic changes occurred in the sod crop and beef cattle organizations in every resource situation. Coastal Bermuda replaced all summer sod crops associated with the sand and clay farm situations. All summer sods found on the levee farm were also converted to Coastal except the levee pasture which cannot be disturbed.

Little or no adjustment in the acreage of fescue associated with the present farm organizations occurred. Additional winter grazing was obtained through better utilization of stalk fields or residue grazing supplied by the row crop enterprises and the supplemental grazing provided by oats.

The changes in sod crop organization resulted in an expansion of the cow-calf enterprise associated with every resource situation. Percentage increase in herd size was greatest (143 to 146 percent) on the large farms as a rather intensive grazing system replaced an extensive one.

Table 3. Soils distribution and optimum land use, 5 typical crop-livestock resource situations, Yazoo-Mississippi Delta.

	Resource situation				
	Small		Large		
Item	Sand	Clay	Sand	Clay	Levee[1]
	Acres	Acres	Acres	Acres	Acres
Total land	820	688	2,500	2,420	1.862
Sand	293	0	895	0	566
Loam	120	35	364	108	231
Clay 1	59	374	199	1,175	121
Clay 2					
Pasture	127	45	368	116	265
Land in crop	472	409	1.458	1,283	918
Pasture land	149	202	454	714	601
Total pasture	276	247	822	830	866
Woods	72	32	220	307	78

[1] See footnote 1, table 1.

Table 4. Optimum cropland organization by crop and soil type and pasture land by sod crop, 5 typical resource situations, Yazoo-Mississippi Delta.

		Resource situation				
		Small		Large		
Item	Unit	Sand	Clay	Sand	Clay	Levee[1]
Cotton						
Sand	Acre	200	0	534	0	338
Loam	Acre	0	35	0	108	0
Clay	Acre	0	139	0	362	0
Oats						
Sand	Acre	93	0	361	0	228
Loam	Acre	62	0	151	0	229
Soybeans						
Loam	Acre	58	0	213	0	2
Clay 1	Acre	59	235	199	813	121
Fescue	Acre	138	110	410	363	363
Levee	Acre	0	0	0	0	279
Coastal Bermuda	Acre	138	137	412	467	224
Beef[2]	Number	154	141	461	474	365
Farm income[3]	Dollar	24,360	13,085	67,443	41,653	41,849

[1] See footnote 1, table 1.

[2] Number of mature brood cows.

[3] Returns to land, management, and overhead.

Optimum grazing systems for small farms permitted a 67 to 78 percent increase in herd size.

Income levels (returns to land, management, and overhead) associated with the optimum crop-livestock organizations were considerably higher than returns from the initial organizations. Farm income increased 15 to 17 percent on the sandy farms, 22 percent on the levee farm, and 74 to 102 percent on the clay farms.

The optimum crop-livestock organizations indicate that a cow-calf enterprise has a place on many Delta farms. However, evaluation of these results indicate that it was impossible to convert the present organization to the optimum in 1 year on any of the farm situations considered in this analysis. Coastal Bermuda requires a minimum of 3 years to attain maximum productive capacity when established on marginal cropland and after Dallis, fescue, or Johnson grass sods. When Coastal replaces common Bermuda sods, the area should be summer fallowed the first year, planted in soybeans the second year, planted to Coastal after the soybean crop is harvested and will be in full production 3 years later.

Since the cow-calf enterprise derives a major part of its feed supply from the sod-crop organization its expansion is directly related to increase in forage output through time.

Dynamic (Time) Analysis

Additional programming was done to determine (1) the total time (in years) required in converting from the present to the optimum organization, and (2) the optimum farm organization for each year involved in the transition period from the present to the optimum organization.

This analysis utilized the same enterprise input-output data used in obtaining the optimum organizations for each farm situation.

Output or production from Coastal Bermuda was varied according to its age in reference to its establishment. Coastal Bermuda 1 year old produced at 40 percent of mature capacity, 2 years old 80 percent of mature capacity, and at 100 percent capacity when 3 years old.

Enterprises forced out of the farm organization in the early part of the transition period were not eliminated from the analysis. In every farm situation considered, the corn enterprise was eliminated from the organization in the first transition year. However, in each following year the corn enterprise's place in the farm organization was again evaluated and either included or eliminated from the organization.

Most Delta farmers will alter their farm organization if the result is an increase in net farm income. However, it was recognized that changes involving long periods of time and/or wide income fluctuations would not be well received.

Thus, the second analysis stipulated (1) that the transition from the present to the optimum organization could not exceed 10 years, and (2) net farm income could not be drastically reduced in any one of the transition years and could never be lower than the income level in the present organization.

Significant changes in the size of the beef cattle enterprise and in its associated grazing system occurred in every farm situation analyzed. Cotton farmers consider beef cattle as a supplementary enterprise, utilizing land, roughage, and labor that would otherwise be unused. Based on this criteria herd expansion was limited to 15 percent per year, 5 percent of the increase to come from the herd and 10 percent could be purchased from other sources.

A brief discussion of the major changes occurring in the organizations of each farm included in the analysis, coupled with the detailed appendix tables may be used as a guide by farmers with similar farm situations, especially when major changes in production enterprises in the farm organization cannot be attained in a short period of time.

Small Sandy Farm. The conversion of summer pastures from common Bermuda, Dallis grass, and Johnson grass to Coastal Bermuda is the most significant change in the grazing system on this farm. The 20 acres of clay 2 soil in cropland was diverted to Coastal Bermuda pasture in the first transition year. These changes were almost complete by the sixth year, but maximum production was not obtained until the eighth year. This prevented the herd from reaching its optimum size until that time. Only minor changes occur in permanent pasture organization after the sixth year and these merely balance the grazing program. However, acreages of oats do continue to increase through year 8 to supply supplemental grazing as the size of the herd increases. This increase in oat acreage for grazing and grain production is at the expense of the soybean acreage on sand and loam soils. Appendix table 1 presents the organization for each transition year for this farm.

Large Sandy Farm. The adjustments necessary to bring this farm to the optimum organization are very similar to those for the small sandy farm. The permanent summer pastures are converted to Coastal Bermuda. This conversion is complete by the seventh year. Again cattle numbers do not reach the optimum until the ninth year because Coastal production does not reach its peak until then.

The acreage of oats increases as cattle numbers increase as on the small sandy farm. This acreage again increases at the expense of soybeans produced on sand and loam soils.

There is little difference in the grazing programs associated with the optimum organizations for either of the sandy farm situations included in the analysis. Both grazing programs are based on the efficient utilization of summer sod crops by grazing, with the excess being harvested as hay. Winter grazing is dependent on the intense utilization of fescue in two periods — from early to mid-winter and from late winter through late spring. Crop residue is utilized in late fall and early winter especially when dry field conditions occur. Five cow days of grazing in December, January, and February are available from each acre of oats. This supplemental grazing plus high grain yields obtained on sand and loam soils make oats more profitable than soybeans.

Hay feeding is held to a minimum in every farm situation. In no instance did hay feeding exceed 35 days in any transition year.

Appendix table 2 presents the organizations for each transition year for this farm.

Small Clay Farm. The problem on this farm is again to convert permanent summer pastures from their present grasses to Coastal Bermuda. This is accomplished by the sixth year for all practical purposes.

The oat enterprise was eliminated from the organization in the first transition year. Soybean acreage increased and all marginal cropland (clay 2 soils) was converted to Coastal Bermuda. Appendix table 3 presents the organizations for each transition year for this farm.

Large Clay Farm. This farm makes the transition from its present organization to the optimum organization in much the same manner as the small clay farm. Present permanent summer pastures are converted to Coastal Bermuda. Oats are eliminated in the first transition year and soybean acreage increases. Appendix table 4 presents the organizations for each transition year for this farm.

As on the sandy farms the grazing programs were almost alike for both clay farms and in neither case were any marked influences of size evidenced. However, there is considerable difference in the cropping patterns and grazing programs associated with the optimum organizations as between sandy and clay resource situations.

It should be noted that both clay farm optimum organizations contained only two row-crops — cotton and soybeans. The oat enterprise was eliminated from the organizations in the first transition year. There is no difference in the amount of supplemental grazing available from oats due to soil type. However, low grain yields usually obtained from oats grown on clay soils make soybeans a more profitable enterprise.

Summer forage is obtained from Coastal Bermuda. Grazing was not as intensive as that practiced on the sandy farms. A considerable amount of hay was harvested with a minimum amount held for winter feeding and the balance sold.

The winter grazing program is diversified with fescue providing forage from mid-winter through early spring. Crop residues are of major importance, providing gazing in (1) late fall in conjunction with grazing of frosted Coastal Bermuda and (2) in early winter. Hay feeding was again held to a minimum of 30 days, generally occurring in late January through mid-February. The hay selling activitity was of considerable importance adding $888 to the small clay farm income and $4,180 to the large clay farm income.

Levee Farm. This farm differs from the others in that it has a large acreage (279) of levee pasture which cannot be disturbed. For this reason opportunities for adjustment are limited. The Johnson grass and Dallis grass pastures are converted to Coastal Bermuda on this farm, but little other change is possible. These changes are accomplished by the third year but herd size does not reach the optimum until the sixth year. Oat acreage increases as herd size increases and soybean production is reduced in the same manner as on sandy farms.

Appendix table 5 presents the organizations for each transition year for this farm.

The optimum organization associated with the levee farm includes a grazing system with a rather extensive summer grazing program and an intensive winter grazing program.

Summer forage is obtained from two rather than one permanent sod crop. The forage obtained from common Bermuda is almost completely utilized by grazing; beginning in late spring and continuing into late summer. Coastal Bermuda provides grazing from early spring through summer and into mid-fall. Almost all of the hay available for feed and for sale was harvested from Coastal Bermuda.

The winter grazing program relies heavily on fescue grazed in two periods —from late fall to mid-winter and from late winter until summer grazing is again available. The 15 days of supplemental grazing per acre obtained from oats is of major importance. Oat grazing supplemented with crop residues or hay provides all of the mid-winter forage.

The amount of crop residues suitable for late fall and mid-winter grazing is limited by the total acreage available. Efficient utilization is facilitated by using it to supplement the late fall grazing of frosted summer sods and the mid-winter grazing of oats.

Hay production declined in importance as the transition from the present to the optimum organization occurred. Again all excess summer forage was harvested as hay with a portion being held for winter feed and the remainder sold.

SUMMARY

Five farm resource situations were used to evaluate the potential position of a cow-calf enterprise in Delta farming systems.

Enterprise alternatives included cotton, corn, oats, soybeans, beef cattle, seven major sod crops, and grass hay. The enterprise budgets were developed from data obtained in several studies and represented current levels of technology. Input and product prices were assumed to be at current levels with some adjustments made for trend and cyclical movements.

Linear programming was used to compute the optimum farm organization for each resource situation considered and to determine the amount of time required to convert the present farm organization to the optimum. Optimum farm organizations for each transition year were obtained for all resource situations studied.

Results of this study indicate that Delta farms with resource situations similar to any of the five analyzed would have higher returns if a cow-calf enterprise were included in the farm organization. Many farms that presently have a cow-calf enterprise included in the organization may increase returns through systematic conversion of marginal cropland and summer sod crops to Coastal Bermuda and expansion of the cow-calf enterprise.

In some cases, major changes in cropping patterns must be made as the proper combination of field crops and sod crops is quite important when the beef enterprise becomes more intensive.

The transitional period from the present to optimum organization will vary from 6 to 10 years, depending on the sod crops being grown and the level of grazing intensity employed. Transitional periods of less than 6 years are almost impossible to obtain economically since maximum forage production from Coastal Bermuda occurs 2 years after establishment.

Appendix table 1. Present and projected optimum organizations, small sandy farm, Yazoo-Mississippi Delta.

Item	Unit	Present	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Farm income	Dollar	21,151	21,437	21,905	22,336	22,232	22,732	22,958	22,704	23,557	24,360
Cropland	Acre	492	472	472	493	472	485	475	472	472	472
Clay 1	Acre	59	59	59	59	59	59	59	59	59	59
Clay 2	Acre	20	0	0	0	0	0	0	0	0	0
Pasture to cropland	Acre	0	0	0	21	0	13	3	0	0	0
Cropland to pasture	Acre	0	20	0	0	21	0	13	3	0	0
Loam	Acre	120	120	120	120	120	120	120	120	120	120
Sand	Acre	293	293	293	293	293	293	293	293	293	293
Idle	Acre	37	0	21[2]	0	13[2]	3[2]	0	0	0	2[2]
Cotton	Acre	200	200	200	200	200	200	200	200	200	200
Corn	Acre	23	0	0	0	0	0	0	0	0	0
Soybeans	Acre	167	214	205	216	183	183	157	137	117	117
On cropland	Acre	167[1]	214	205	195	183	170	155	137	117	117
On pasture	Acre	0	0	0	21	0	13	3	0	0	0
Oats	Acre	85	58	67	77	89	102	117	135	155	155
Total pasture	Acre	256	276	276	255	276	263	273	276	276	276
Fescue	Acre	122	122	122	122	122	122	122	122	122	122
Fescue on common	Acre	0	0	0	0	0	0	0	16	16	16
Common Bermuda	Acre	55	55	34	34	20	18	18	2	2	0
Coastal on common											
Year 2	Acre	0	0	21[2]	0	21	21	21	21	21	21
Year 4	Acre	0	0	0	0	13[2]	0	13	13	13	13
Year 5	Acre	0	0	0	0	0	3[2]	0	3	3	3
Year 9	Acre	0	0	0	0	0	0	0	0	0	2[2]
Dallis	Acre	54	54	54	54	54	0	0	0	0	0
Coastal on Dallis	Acre	0	0	0	0	0	54	54	54	54	54
Johnson	Acre	25	0	0	0	0	0	0	0	0	0
Coastal on Johnson	Acre	0	25	25	25	25	25	25	25	25	25
Coastal on cropland	Acre	0	20	20	20	20	20	20	20	20	20
Herd size	Number	91	58	66	76	88	101	116	134	154	154
Hay sales	Ton	—66[3]	31	49	41	26	0	23	41	41	40

[1] 20 acres after oats. [2] Common overgrazed and fallowed for conversion to Coastal. [3] Negative figure indicates hay purchase.

Appendix table 2. Present and projected optimum organizations, large sandy farm, Yazoo-Mississippi Delta.

Item	Unit	Present	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Farm income	Dollar	56,938	59,583	60,291	63,345	62,414	63,234	66,269	65,021	66,067	67,443
Cropland	Acre	1,500	1,458	1,458	1,531	1,458	1,458	1,513	1,458	1,458	1,458
Clay 1	Acre	199	199	199	199	199	199	199	199	199	199
Clay 2	Acre	42	0	0	0	0	0	0	0	0	0
Pasture to cropland	Acre	0	0	0	73	0	0	55	0	0	0
Cropland to pasture	Acre	0	42	0	0	73	0	0	55	0	0
Loam	Acre	364	364	364	364	364	364	364	364	364	364
Sand	Acre	895	895	895	895	895	895	895	895	895	895
Idle	Acre	53	0	73[2]	0	0	55[2]	0	0	0	0
Cotton	Acre	534	534	534	534	534	534	534	534	534	534
Corn	Acre	108	0	0	0	0	0	0	0	0	0
Soybeans	Acre	534[1]	739	711	762	642	600	606	495	431	412
On cropland	Acre	534[1]	739	711	679	642	600	551	495	431	412
On pasture	Acre	0	0	0	73	0	0	55	0	0	0
Oats	Acre	315	185	213	245	282	324	373	429	493	512
Total pasture	Acre	780	822	822	749	822	822	767	822	822	822
Fescue	Acre	369	369	369	369	369	369	369	369	369	369
Fescue on common											
Year 7	Acre	0	0	0	0	0	0	0	21	21	21
Year 8	Acre	0	0	0	0	0	0	0	0	21	21
Common Bermhda	Acre	170	170	97	97	97	42	42	21	0	0
Coastal on common											
Year 2	Acre	0	0	73[2]	0	73	73	73	73	73	73
Year 5	Acre	0	0	0	0	0	55[2]	0	55	55	55
Dallis	Acre	165	165	165	165	165	24	0	0	0	0
Coastal on Dallis											
Year 5	Acre	0	0	0	0	0	141	141	141	141	141
Year 6	Acre	0	0	0	0	0	0	24	24	24	24
Johnson	Acre	76	0	0	0	0	0	0	0	0	0
Coastal on Johnson	Acre	0	76	76	76	76	76	76	76	76	76
Coastal on cropland	Acre	0	42	42	42	42	42	42	42	42	42
Herd size	Number	190	167	192	221	254	292	336	387	445	461
Hay sales	Ton	—238	36	125	90	91	10	—11	132	143	129

[1] 44 acres after oats. [2] Common overgrazed and fallowed for conversion to Coastal. [3] Negative figure indicates hay purchases.

Appendix table 3. Present and projected optimum organizations, small clay farm, Yazoo-Mississippi Delta.

Item	Unit	Present	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Farm income	Dollar	7,523	10,657	10,600	11,439	11,818	12,063	12,188	12,299	12,917	13,085
Cropland	Acre	431	409	409	426	422	423	411	409	409	409
Clay 1	Acre	374	374	374	374	374	374	374	374	374	374
Clay 2	Acre	22	0	0	0	0	0	0	0	0	0
Pasture to cropland	Acre	0	0	0	17	6	0	0	0	0	0
Cropland to pasture	Acre	0	22	0	0	17	6	0	0	0	0
Loam	Acre	35	35	35	35	35	35	35	35	35	35
Non-cropland											
Pasture to cropland	Acre	0	0	0	0	7	14	2	0	0	0
Cropland to pasture	Acre	0	0	0	0	0	7	14	2	0	0
Idle	Acre	32	0	17[2]	13[2]	14[2]	2[2]	0	0	0	0
Cotton	Acre	174	174	174	174	174	174	174	174	174	174
Corn	Acre	20	0	0	0	0	0	0	2	2	2
Soybeans	Acre	149[1]	235	235	252	248	249	237	235	235	235
On cropland	Acre	149[1]	235	235	235	235	235	235	235	235	235
On pasture	Acre	0	0	0	17	13	14	2	0	0	0
Oats	Acre	74	0	0	0	0	0	0	0	0	0
Total pasture	Acre	225	247	247	230	234	233	245	247	247	247
Fescue	Acre	108	108	108	108	108	108	108	108	108	108
Fescue on common	Acre	0	0	0	0	0	0	0	2	2	2
Common	Acre	48	48	31	18	4	2	2	0	0	0
Coastal on common											
Year 2	Acre	0	0	17[2]	0	17	17	17	17	17	17
Year 3	Acre	0	0	0	13[2]	0	13	13	13	13	13
Year 4	Acre	0	0	0	0	14[2]	0	14	14	14	14
Year 5	Acre	0	0	0	0	0	2[2]	0	2	2	2
Dallis	Acre	47	47	47	47	47	0	0	0	0	0
Coastal on Dallis	Acre	0	0	0	0	0	47	47	47	47	47
Johnson	Acre	22	0	0	0	0	0	0	0	0	0
Coastal on Johnson	Acre	0	22	22	22	22	22	22	22	22	22
Coastal on cropland	Acre	0	22	22	22	22	22	22	22	22	22
Herd size	Number	79	53	61	70	80	92	106	122	140	141
Hay sales	Ton	—85[3]	27	49	35	10	0	38	85	73	74

[1] 18 acres soybeans after oats. [2] Common overgrazed and fallowed for conversion to Coastal. [3] Negative figure indicates hay purchase.

Appendix table 4. Present and projected optimum organizations, large clay farm, Yazoo-Mississippi Delta.

Item	Unit	Present	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Farm income	Dollar	20,733	31,731	31,860	35,209	35,155	34,942	39,532	38,080	39,687	41,653
Cropland	Acre	1,320	1,283	1,283	1,358	1,305	1,283	1,360	1,283	1,283	1,283
Clay 1	Acre	1,175	1,175	1,175	1,175	1,175	1,175	1,175	1,175	1,175	1,175
Clay 2	Acre	37	0	0	0	0	0	0	0	0	0
Pasture to cropland	Acre	0	0	0	75	4	0	0	0	0	0
Cropland to pasture	Acre	0	37	0	0	75	4	0	0	0	0
Loam	Acre	108	108	108	108	108	108	108	108	108	108
Noncropland											
Pasture to cropland	Acre	0	0	0	0	18	0	77	0	0	0
Cropland to pasture	Acre	0	0	0	0	0	18	0	77	0	0
Idle	Acre	46	0	75[2]	22[2]	0	77[2]	0	0	0	0
Cotton	Acre	470	470	470	470	470	470	470	470	470	470
Corn	Acre	95	0	0	0	0	0	0	0	0	0
Soybeans	Acre	470[1]	813	813	888	835	813	890	813	813	813
On cropland	Acre	470[1]	813	813	813	813	813	813	813	813	813
On pasture	Acre	0	0	0	75	22	0	77	0	0	0
Oats	Acre	276	0	0	0	0	0	0	0	0	0
Total pasture	Acre	793	830	830	755	808	830	753	830	830	830
Fescue	Acre	374	363	363	363	363	363	363	363	363	363
Coastal on fescue	Acre	0	11	11	11	11	11	11	11	11	11
Common	Acre	174	174	99	77	77	0	0	0	0	0
Coastal on common											
Year 2	Acre	0	0	75[2]	0	75	75	75	75	75	75
Year 3	Acre	0	0	0	22[2]	0	22	22	22	22	22
Year 5	Acre	0	0	0	0	0	77[2]	0	77	77	77
Dallis	Acre	168	168	168	168	168	37	0	0	0	0
Coastal on Dallis											
Year 5	Acre	0	0	0	0	0	131	131	131	131	131
Year 6	Acre	0	0	0	0	0	0	37	37	37	37
Johnson	Acre	77	0	0	0	0	0	0	0	0	0
Coastal on Johnson	Acre	0	77	77	77	77	77	77	77	77	77
Coastal on cropland	Acre	0	37	37	37	37	37	37	37	37	37
Herd size	Number	193	172	198	228	262	302	347	399	459	473
Hay sales	Ton	—98[3]	96	127	75	67	1	0	166	231	265

[1] 37 acres after oats. [2] Common overgrazed and fallowed for conversion to Coastal. [3] Negative figure indicates hay purchases.

Appendix table 5. Present and projected optimum organizations, levee farm, Yazoo-Mississippi Delta.

Item	Unit	Present	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Farm income	Dollar	34,208	37,483	37,738	38,603	39,672	40,314	41,849	41,849	41,849	41,849
Cropland	Acre	950	918	918	918	918	918	918	918	918	918
Clay 1	Acre	121	121	121	121	121	121	121	121	121	121
Clay 2	Acre	32	0	0	0	0	0	0	0	0	0
Pasture to cropland	Acre	0	0	0	0	0	0	0	0	0	0
Cropland to pasture	Acre	0	32	0	0	0	0	0	0	0	0
Loam	Acre	231	231	231	231	231	231	231	231	231	231
Sand	Acre	566	566	566	566	566	566	566	566	566	566
Idle	Acre	33	0	0	0	0	0	0	0	0	0
Cotton	Acre	338	338	338	338	338	338	338	338	338	338
Corn	Acre	68	0	0	0	0	0	0	0	0	0
Soybeans	Acre	315[1]	352	317	278	233	181	123	123	123	123
On cropland	Acre	315[1]	352	317	278	233	181	123	123	123	123
On pasture	Acre	0	0	0	0	0	0	0	0	0	0
Oats	Acre	228	228	263	302	347	399	457	457	457	457
Total pasture	Acre	834	866	866	866	866	866	866	866	866	866
Fescue	Acre	367	363	363	363	363	363	363	363	363	363
Coastal on fescue	Acre	0	4	4	4	4	4	4	4	4	4
Levee	Acre	279	279	279	279	279	279	279	279	279	279
Dallis	Acre	108	108	0	0	0	0	0	0	0	0
Coastal on Dallis	Acre	0	0	108	108	108	108	108	108	108	108
Johnson	Acre	80	0	0	0	0	0	0	0	0	0
Coastal on Johnson	Acre	0	80	80	80	80	80	80	80	80	80
Coastal on cropland	Acre	0	32	32	32	32	32	32	32	32	32
Herd size	Number	219	183	210	242	278	319	365	365	365	365
Hay sales	Ton	—251[2]	133	208	176	143	166	104	104	104	104

[1] 32 acres soybeans after oats. [2] Negative figure indicates hay purchase.

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Mississippi
Cotton Variety Tests
Delta And Hill Sections,
1965

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Yield, earliness, lint percent, boll size, seed index, fiber properties for the 1965 cotton variety test at Stoneville, Mississippi.

Stoneville

	lint per acre Yield pounds						Fiber properties				
							Staple	Length			
Variety	Total	First pick	Percent first pick	Percent lint	Seed index	No. bolls per lb.	Classer	UHM	Strength T_1	Elongation E_1	Micronaire
Stoneville 7A	1281	1176	92	38.1	11.0	73	1-1/16+	1.09	1.78	7.31	5.29
Deltapine 5481	1246	1123	90	38.9	10.5	75	1-1/16+	1.09	1.93	9.11	4.65
Stoneville 213	1231	1128	92	37.5	11.4	72	1-1/16	1.09	1.88	7.72	5.10
Deltapine 5916	1200	1071	89	37.3	11.3	67	1-3/32	1.12	1.96	9.62	5.24
Deltapine 45A	1176	1077	92	37.9	11.6	71	1-3/32	1.06	1.93	7.81	5.33
Deltapine 45	1144	1039	91	36.8	12.0	70	1-1/16+	1.08	2.01	7.91	5.23
Deltapine Sm. Lf.	1116	977	87	37.0	10.7	71	1-1/16	1.11	2.00	8.38	5.10
Rex Smoothleaf	1086	978	90	34.3	13.3	59	1-1/16+	1.07	1.73	7.51	4.68
Empire WR 61	1070	975	91	35.9	14.1	54	1-3/32	1.05	1.81	6.67	4.35
Stardel	1067	970	91	37.0	11.7	74	1-1/16+	1.09	2.12	6.50	5.01
McNair 1032	1066	924	87	36.0	12.0	73	1-1/16	1.01	1.93	6.56	5.45
Auburn 56	1045	948	91	34.5	12.3	67	1-1/16+	1.05	1.83	7.62	4.89
DeKalb 220	1044	947	91	36.0	12.2	64	1-3/32	1.13	1.83	7.95	4.77
Dixie King 6374	1043	942	90	38.2	11.5	67	1-1/16	1.04	1.82	6.37	5.18
Delfos 9169	1030	941	91	34.2	13.6	64	1-3/32	1.16	1.75	8.08	4.45
Auburn M	1030	899	87	35.4	13.4	64	1-1/16+	1.07	1.84	7.68	4.78
Dixie King II	1016	913	90	36.3	12.3	62	1-1/16+	1.06	1.84	6.66	4.76
Carolina Queen	1008	878	87	37.5	12.3	68	1-1/16+	1.08	1.88	6.55	5.35
Acala 4447	1008	890	88	37.7	12.6	59	1-3/32+	1.08	2.47	6.61	4.65
Coker 100A	1002	911	91	35.3	12.0	67	1-3/32	1.13	1.95	7.46	4.85
C.V.	7.3	7.6		2.0				2.1	2.7	5.7	3.9
LSD .05	95	85		0.84				.048	0.11	0.90	0.41
LSD .01	126	114		1.11				.066	0.15	1.23	0.56

Planted April 28; harvested September 27 and November 1. Soil: Deer Creek sandy loam.

Mississippi Cotton Variety Tests For 1965

IN THE DELTA

BY ROBERT R. BRIDGE, WILLIAM R. MEREDITH, JR., AND JAMES F. CHISM[1]

A major factor in the yield and quality of the harvested cotton crop is the variety of cotton planted. Therefore, each year the Delta Branch Experiment Station tests promising varieties in different regions of the state.

Continued testing and evaluation of cotton varieties and experimental strains are essential in providing a guide for farmers interested in the best adapted varieties having the highest possible yield and quality for their respected areas of interest. Quality is the key to cotton price and market demand.

Desirable staple length, uniformity strength, and micronaire have drawn added attention in 1965. Premiums and discounts are being made on the basis of micronaire this year. Therefore, quality is important to the cotton grower because it determines the price he receives and the continuing demand for his product.

Farmers who consider quality in addition to total yield when selecting a variety to plant, over a period of time will improve the quality of cotton going to the market and thereby help insure cotton a strong position in competition with other fibers.

Three Locations in 1965

Cotton variety trials were conducted by the Delta Branch Experiment Station in 1965 at three locations; the Delta Station at Stoneville, Woolfolk Plantation near Tunica, and Schaefer Plantation near Yazoo City.

The 1965 season was very favorable for cotton production with the exception of some local drought conditions and the damage caused by hurricane Betsy in many areas. The earlier varieties at Stoneville and Yazoo City suffered the most damage due to the hurricane with very little damage resulting at Tunica. The variety tests were planted in April and early May with good stands recorded at all locations. Supplemental irrigation was used at Stoneville and Tunica due to the hot, dry weather conditions during July and August.

Current strains of 20 commercial varieties were grown at all locations in 1965. Twelve varieties grown at Stoneville and Tunica are included in a cooperative beltwide variety testing program.

Results in Tables

Results are reported at each location for the 1965 variety tests. Yield data were based on the weight of cotton harvested from the two center rows of four row plots. Each plot was randomized and replicated six times. The lint percentages reported were determined from samples taken directly from the plot picker at Stoneville and from hand-picked samples at Yazoo City and Tunica. Two lint percentage determinations were made at Tunica because of the dampness of the samples taken at the first picking. The average lint percent, seed index, and boll size were approximately the same for all locations, but the average length, strength, and micronaire were higher at Tunica.

Classing was done by the Staple Cotton

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Cooperative Association in Greenwood, Mississippi. Fiber properties data were determined by the fiber laboratory of Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, at Knoxville, Tennessee.

Results of the 1965 variety trials are shown in the accompanying tables.

Average yield, lint percent, seed index, boll size and fiber properties of 20 varieties at three Delta locations, Stoneville, Mississippi, 1965.

Stoneville Variety	Yield lbs. lint per acre	Percent lint	Seed index	Boll size grms.	Fiber properties Length UHM	Strength T_1	Elongation E_1	Micronaire
Stoneville 213	1049	37.6	11.4	5.98	1.11	1.91	7.16	5.23
Stoneville 7A	1032	37.6	11.4	5.78	1.13	1.82	6.56	5.27
Deltapine 5916	1015	37.3	11.7	6.34	1.12	1.98	8.52	5.27
Deltapine 5481	1007	39.1	10.8	5.73	1.11	1.94	8.79	4.79
Deltapine 45A	1004	37.7	11.9	6.04	1.10	1.99	7.87	5.31
Dixie King 6374	978	38.2	12.0	6.54	1.07	1.80	6.48	5.14
Carolina Queen	972	37.3	12.5	6.28	1.12	1.92	6.34	5.28
McNair 1032	968	36.5	11.8	5.94	1.04	2.00	6.44	5.26
Deltapine 45	961	36.9	12.0	6.05	1.10	2.02	7.59	5.20
Deltapine Smooth Leaf	952	37.2	10.7	6.02	1.11	1.97	8.21	5.16
Auburn 56	947	35.0	12.4	6.22	1.09	1.88	7.27	4.98
Empire WR 61	924	35.8	14.4	7.72	1.09	1.85	6.43	4.61
Delfos 9169	922	34.5	13.2	6.77	1.19	1.82	7.58	4.36
Stardel	920	37.4	12.2	5.83	1.10	2.11	6.29	5.08
Dixie King II	918	36.7	12.7	7.08	1.09	1.89	6.24	4.88
Auburn M	907	35.1	13.7	6.47	1.10	1.96	7.00	4.66
Rex Smoothleaf	901	35,1	13.7	6.87	1.10	1.82	7.07	4.75
Coker 100A	887	36.1	12.1	6.28	1.13	1.95	6.78	4.93
DeKalb 220	883	35.7	12.2	6.63	1.12	1.84	7.20	4.77
Acala 4447	879	37.2	13.7	6.97	1.11	2.46	6.13	4.83

Yield, earliness, lint percent, boll size, seed index, and fiber properties for the 1955 cotton variety test at Yazoo City, Mississippi.

Yazoo City Variety	Yield lbs. lint per acre Total	Per-cent lint	Seed index	No. bolls per lb.	Fiber properties Staple Classer	Length UHM	Strength T_1	Elongation E_1	Micronaire
Carolina Queen	1083	38.1	11.7	74	1-3/32	1.10	1.84	6.42	5.06
Stoneville 213	1024	37.9	10.9	76	1-1/32	1.07	1.85	7.54	5.31
Dixie King 6374	1017	38.7	12.1	69	1-1/32+	1.06	1.76	7.10	5.07
McNair 1032	976	36.7	11.2	75	1-1/32+	1.03	2.06	6.70	5.15
Stoneville 7A	967	37.2	11.1	82	1-1/16	1.11	1.80	6.80	5.18
Auburn 56	937	35.3	12.1	73	1-1/16	1.07	1.89	7.13	4.84
Deltapine 5916	920	37.6	11.2	71	1-1/32+	1.09	1.99	8.81	5.46
Deltapine 45A	903	38.6	11.5	77	1-1/16	1.08	1.93	8.06	5.26
Deltapine 5481	895	40.2	10.7	78	1-1/32	1.05	1.93	9.13	4.93
Dixie King II	886	37.1	12.5	65	1-1/16	1.07	1.91	6.40	4.89
Empire WR 61	879	35.8	14.7	59	1-1/16	1.09	1.91	6.67	4.61
Deltapine Sm. Lf.	877	38.2	10.6	78	1-1/32	1.07	1.96	8.67	5.12
Deltapine 45	875	37.5	11.5	77	1-1/16	1.06	1.95	8.09	5.23
Delfos 9169	869	35.1	12.9	67	1-3/32	1.17	1.85	7.88	4.27
Auburn M	868	34.3	13.8	71	1-1/16+	1.07	2.00	6.57	4.54
DeKalb 220	867	36.1	11.8	69	1-1/16+	1.08	1.88	7.47	4.73
Rex Smoothleaf	864	36.1	13.5	67	1-1/32+	1.06	1.85	6.88	4.70
Acala 4447	861	37.6	13.3	66	1-1/16+	1.08	2.40	6.13	4.72
Coker 100A	844	37.8	11.8	73	1-1/32	1.09	1.94	6.62	4.81
Stardel	777	38.0	12.1	80	1-1/32	1.07	2.13	6.27	5.07
C.V.	11.05	2.13				2.1	4.9	4.7	1.50
LSD .05	114	0.91				0.048	0.20	0.71	0.15
LSD .01	151	1.20				0.066	0.27	0.97	0.21

Planted April 22; harvested September 15.

Yield, earliness, lint percent, boll size, seed index, and fiber properties for the 1965 cotton variety test at Tunica, Mississippi.

Tunica

	Yield pounds lint per acre			Lint percent				Fiber properties				
Variety	Total	First pick	Percent first pick	first pick	Second pick	Seed index	No. bolls per lb.	Staple Classer	Length UHM	Strength T_1	Elongation E_1	Micronaire
Deltapine 45A	934	730	78	34.7	36.7	12.6	76	1-3/32	1.17	2.12	7.75	5.33
Deltapine 5916	926	653	71	34.4	37.1	12.5	77	1-1/16+	1.16	2.00	7.14	5.10
Stardel	916	767	84	34.9	37.1	12.7	79	1-1/16+	1.15	2.07	6.10	5.17
Stoneville 213	892	706	79	35.2	37.3	11.8	78	1-3/32	1.16	1.99	6.23	5.29
Deltapine 5481	879	676	77	35.9	38.3	11.3	84	1-3/32	1.15	1.96	8.12	4.79
Dixie King 6374	875	646	74	35.6	37.7	12.3	72	1-1/16	1.10	1.83	5.96	5.21
Delfos 9169	866	722	83	31.9	34.1	13.2	70	1-1/8	1.24	1.87	6.79	4.36
Deltapine 45	864	730	84	34.3	36.3	12.5	78	1-1/16+	1.15	2.11	6.76	5.15
McNair 1032	863	602	70	33.9	36.8	12.3	81	1-1/16	1.09	2.00	6.07	5.18
Deltapine Sm. Lf.	863	568	66	34.5	36.5	10.9	76	1-1/16+	1.16	1.96	7.57	5.26
Auburn 56	860	664	77	32.1	35.1	12.8	80	1-1/16+	1.14	1.92	7.06	5.21
Dixie King II	851	699	82	34.3	36.6	13.3	64	1-1/16+	1.15	1.91	5.66	5.00
Stoneville 7A	847	652	77	34.5	37.4	12.2	80	1-1/16	1.20	1.87	5.56	5.33
Carolina Queen	826	640	77	34.4	36.4	13.4	73	1-1/16+	1.19	2.04	6.05	5.43
Empire WR 61	824	746	91	33.5	35.8	14.4	63	1-1/16+	1.14	1.82	5.94	4.88
Auburn M	822	653	79	32.7	35.5	13.8	75	1-1/16	1.17	2.04	6.74	4.65
Coker 100A	814	618	76	33.0	35.3	12.6	77	1-3/32+	1.18	1.96	6.27	5.14
Acala 4447	767	660	86	35.3	36.4	15.0	70	1-3/32+	1.18	2.50	5.66	5.12
Rex Smoothleaf	752	596	79	33.4	34.8	14.2	73	1-1/16+	1.17	1.87	6.83	4.88
DeKalb 220	738	576	78	33.4	35.0	12.7	72	1-3/32+	1.16	1.81	6.18	4.81
C.V.	11.8	15.9		2.7					2.0	3.3	5.1	3.9
LSD .05	114	120		1.05					0.048	0.14	0.69	0.41
LSD .01	152	161		1.39					0.066	0.19	0.94	0.56

Planted May 7; Harvested September 29 and November 4.

COTTON TESTS IN HILL SECTION

By G. D. GREEN, R. C. ALBRITTON, R. E. COATS, S. P. CROCKETT, W. J. GILL, B. C. HURT, JR., AND B. E. WAGGONER

Stoneville 213 and Carolina Queen led Experiment Station cotton variety tests in 1965 as well as in 1963 and 1964 when yields at the nine locations were averaged. Because varieties did not produce in the same order at each location or during each year, it is suggested that a person study the average test results of the Experiment Station with conditions most nearly like his own.

Generally the yield of lint produced should be the major consideration in selecting a variety. Among other considerations are disease resistance, lint percent, staple length, size of boll, picking qualities, and probably earliness and smoothness of leaves. The following discussion is limited to the varieties in these test.

If wilt disease is present to any appreci-

Summary Tables

Highest yielding cotton varieties, 1963, 1964, and 1965 average, Central Station and various Hill Section Branch Stations, Mississippi.

	State	Brooks-	New-	Ray-	Pontotoc		Holly Springs		
Variety	College	ville	ton	mond	Ridge	F'wds	Hill	Bottom	Verona
				Yield, pounds lint per acre					
Stoneville 213	833	1103		1172			872	1103	735
Carolina Queen			928		936	767		1115	
Stoneville 7A		1094							750
Empire WR 61				1192					
Auburn M							866		
DeKalb 220									745
Deltapine 45									744
Stoneville 3202									744
Deltapine Sm. Lf									738
Auburn 56									751

Summary table showing average yields in hill section cotton variety tests in 1965.

	State	Brooks-	New-	Ray-	Pontotoc		Holly Springs			
Variety	College	ville	ton	mond	Ridge	F'wds	Hill	Bottom	Verona	Ave
					Pounds of lint per acre					
Stoneville 213	1031	1154	964	1201	860	587	712	906	934	928
Carolina Queen	946	1024	965	1270	950	752	646	836	957	927
Coker 100A WR	1062	1025	853	1114	829	762	639	788	988	896
Stoneville 7A	981	1132	854	992	911	597	649	868	988	886
DeKalb 128	836	1013	934	1436	822	534	598	853	925	883
DeKalb 108	979	1017	940	1138	877	565	624	845	945	881
Dixie King II	846	1041	772	1006	1067	593	719	864	1017	881
Delta Hy-Bee	782	1026	874	1232	870	529	651	851	1003	869
Deltapine 45	966	1044	931	1035	901	546	577	804	1011	868
Pennington Hy-Bee	824	1023	959	1053	875	546	682	929	900	866
Deltapine Sm. Lf.	957	1103	844	1174	784	454	613	899	922	861
McNair 1032	827	983	1007	1144	793	624	576	871	835	851
Auburn 56	848	1006	814	1122	810	638	630	887	900	850
Empire WR 61	930	998	771	1233	869	581	600	750	877	845
Deltapine 45A	837	1007	827	1036	852	516	570	855	1046	838
Stoneville 3202	931	1016	792	1032	849	574	588	854	895	837
Rex Smoothleaf	845	1016	848	1037	912	601	665	824	762	834
DeKalb 220	839	1008	932	1015	819	472	625	893	872	831
Auburn M	917	841	830	742	798	693	644	816	709	777

able extent in a field, a resistant or tolerant variety should be used. Carolina Queen has some resistance to Fursarium wilt but not as much as Auburn 56, Auburn M, McNair 1032 or Coker 100 A WR, Dixie King II, DeKalb 108, Empire WR 61 and Rex Smoothleaf are resistant. The following varieties have some tolerance to Verticillium wilt; Auburn M, Auburn 56, Coker 100A, Stoneville 7 and Rex Smoothleaf. Auburn M, Rex Smoothleaf and Empire WR 61 cut-out somewhat earlier than the other varieties. Deltapine 45A is replacing Deltapine 45.

Lint percentage or gin turn-out will vary more with the amount of foreign material in the seed cotton, the season, and location than with the variety. Staple

State College

3-Year Averages, Central Station, State College, Miss.

Variety	Yield, lbs. lint per A. 1963	1964	1965	Ave.	Acre value, dollars	Lint per-cent	Staple 32nds. inch	Bolls per lb. Lint	Seed cotton	Pct. first picking *
Stoneville 213	740	728	1031	833	272	38.7	34.0	178	69	79
Auburn M	836	586	917	780	259	37.1	34.2	173	64	84
Stoneville 7A	722	629	981	777	259	38.0	35.0	185	70	77
Carolina Queen	807	574	946	776	256	38.5	34.3	168	64	79
Coker 100A WR	713	515	1062	763	252	37.5	34.5	178	67	71
Auburn 56	801	621	848	757	251	35.9	34.0	182	66	82
DeKalb 220	847	562	839	749	250	37.5	34.2	166	62	78
Deltapine Sm. Lf.	676	610	957	748	244	38.2	34.1	195	75	76
Stoneville 3202	687	617	931	745	244	37.6	33.8	183	69	80
Empire WR 61	711	566	930	736	243	36.6	34.5	146	53	82
Rex Smoothleaf	786	564	845	732	243	37.1	34.5	164	61	85
DeKalb 108	727	488	979	731	241	36.5	34.0	176	64	81
Deltapine 45	574	550	966	697	226	37.9	34.0	189	71	74

*1963 and 1965 average.

State College, 1965

Variety	Yield per A., lbs. Seed cotton	Lint	Dollar val. per A., SLM	Lint pct.	Staple 32nds. inch	Bolls per pound Seed cotton	Lint	Pct. first picking
Coker 100A	2814	1062	319	37.7	35.0	65	172	61
Stoneville 213	2661	1031	303	38.7	34.7	65	169	74
Stoneville 7A	2542	981	294	38.6	35.0	64	166	71
Dekalb 108	2631	979	288	37.2	34.3	61	164	76
Deltapine 45	2480	966	283	38.9	34.3	65	168	75
Deltapine Sm. Lf.	2435	957	281	39.3	34.7	71	180	73
Carolina Queen	2420	946	278	39.1	34.7	59	152	75
Stoneville 3202	2416	931	273	38.5	34.0	64	166	73
Empire WR 61	2567	930	273	36.2	34.3	48	135	75
Auburn M	2487	917	270	36.8	34.7	60	162	79
Auburn 56	2372	848	249	35.7	34.3	60	168	73
Dixie King II	2194	846	248	38.5	34.3	56	145	79
Rex Smoothleaf	2281	845	248	37.0	34.7	55	150	79
Dekalb 220	2229	839	247	37.6	34.7	59	157	73
Deltapine 45A	2169	837	246	38.5	34.3	69	179	68
Dekalb 128	2233	836	251	37.4	35.3	57	153	71
McNair 1032	2219	827	243	37.3	34.0	65	174	67
Pennington Hy-Bee	2213	824	242	37.2	34.7	59	159	71
Delta Hy-Bee	2046	782	230	38.2	34.7	62	163	70
LSD @ 5%		NS						
C. V.		16.2%						

Planted: April 27; Soil: Verona fine sandy loam; Fertilizer: 52-52-52; Poisoned 12 times.

length will vary more with the classer determining the length, the season and location than with the variety. Size of bolls varies considerably among varieties, seasons and location. The human picker prefers large bolls, the machine has no preference. Picking quality varies some among varieties, but insect and disease damage, the condition of the plants, amount of boll rot, etc. can easily offset this.

Percent picked at first picking was calculated where more than one picking was made as an indication of earliness. It may be noted that there are no varieties outstanding for earliness nor lateness. Auburn M, Empire WR 61, Rex Smoothleaf, and Stoneville 3202 are generally slightly

Black Belt

3-Year Averages, Black Belt Station, Brooksville

Variety	Yield, lbs. lint per A. 1963	1964	1965	Ave.	Acre value, dollars	Lint per-cent	Staple 32nds. inch	Bolls per lb. Lint	Seed cotton	Pct. first picking
Stoneville 213	1227	928	1154	1103	364	40.4	34.2	196	77	57
Stoneville 7A	1185	965	1132	1094	364	40.2	34.7	186	75	51
Deltapine Sm. Lf	1238	818	1103	1053	351	39.8	34.5	207	82	57
Carolina Queen	1174	901	1024	1033	345	39.4	34.4	187	73	56
Deltapine 45	1166	882	1044	1031	343	39.9	34.4	200	80	55
Stoneville 3202	1136	893	1016	1015	333	39.2	33.8	192	75	60
DeKalb 220	1132	761	1008	967	324	37.9	34.4	182	69	56
Coker 100A	1074	768	1025	956	317	38.2	34.5	196	75	56
DeKalb 108	967	764	1017	916	306	38.1	34.8	182	69	59
Auburn 56	967	763	1006	912	302	37.1	34.1	200	74	62
Empire WR 61	957	716	998	890	300	36.6	34.9	170	62	63
Rex Smoothleaf	845	762	1016	874	291	37.5	34.7	179	67	66
Auburn M	841	709	841	797	264	37.4	34.0	193	72	64

Brooksville, 1965

Variety	Yield per A., lbs. Seed cotton	Lint	Dollar val. per A., SLM	Lint pct.	Staple 32nds. inch	Bolls per pound Seed cotton	Lint	Pct. first picking
Stoneville 213	2800	1154	331	41.2	33.3	75	182	55
Stoneville 7A	2772	1132	332	40.8	34.3	73	179	47
Deltapine Sm. Lf.	2675	1103	323	41.2	34.3	87	212	51
Deltapine 45	2616	1044	306	39.9	34.3	79	199	53
Dixie King II	2571	1041	299	40.5	33.3	64	160	63
Delta Hy-Bee	2605	1026	308	39.4	35.0	70	179	61
Coker 100A	2622	1025	294	39.1	33.7	73	186	56
Carolina Queen	2553	1024	300	40.1	34.0	73	184	51
Pennington Hy-Bee	2599	1023	300	39.3	34.3	66	169	61
Dekalb 108	2569	1017	298	39.6	34.3	70	178	57
Rex Smoothleaf	2598	1016	298	39.1	34.0	69	178	67
Stoneville 3202	2572	1016	284	39.5	32.7	74	187	58
Dekalb 128	2571	1013	297	39.4	34.0	66	168	56
Dekalb 220	2622	1008	296	38.4	34.3	69	180	54
Deltapine 45A	2526	1007	289	39.8	33.3	77	193	55
Auburn 56	2637	1006	289	38.1	33.7	73	192	57
Empire WR 61	2638	998	293	37.8	34.0	65	173	59
McNair 1032	2528	983	282	38.9	33.0	78	202	56
Auburn M	2153	841	241	39.0	33.3	70	179	62
LSD @ 5%		124						
C. V.		10.5%						

Planted: April 16; Soil: Houston Clay; Fertilizer: 120-60-60; Poisoned: 12.

earlier than most of the others.

Smooth-leaved cotton should harvest cleaner and clean better at the gin than hairy-leaved cotton. Many things can offset this, also, as the degree of defoliation, the amount of insect and disease damage including boll rot, the soundness of the plant and burs at harvest, the method and care used in harvesting, the amount and efficiency of cleaning equipment at the gin, etc.

These varieties are all good. Home grown seed may be as good or better than bought seed provided they are not too many years from certified seed. Planting seed of cotton should by all means be treated and tested for germination. The State Seed Laboratory, Box 456, State College, Mississippi will test 8 samples of seed each year free for residents of Mississippi. For the test to be reliable, the sample must be representative of all the seed in the lot. Small quantities of seed can be tested satisfactorily at home if directions are followed. Delinted seed can be planted more accurately.

The Experiment Station tests reported here included 19 varieties at the nine locations and results shown in the tables. DeKalb 128, Deltapine 45A, Delta Hy-Bee and McNair 1032 were new entries.

Good yields were obtained at all locations. It was cool when the test was planted at State College and the stand was poor, particularly of the acid delinted seed. The test on Flatwoods soil at Pontotoc was replanted twice, and the stand even then was not good. Standard corrections were made for skips if reported to the senior author. It was dry at all locations in May and June and at Pontotoc and Holly Springs throughout the season. July was wet at State College. Insect and weed control were satisfactory.

The lint price used in calculating the value per acre was the Government loan price for Starkville, Mississippi for Strict Low Middling cotton which is about the average grade for the Mississippi crop. The staple length used was that of that variety in the particular test. Seed was valued at $48 per ton.

The term LSD @ 5% in the tables means least significant difference at odds of 19 to 1. This indicates that statistically the odds are 19 to 1 that a difference in yield between varieties in that test of less than the amount shown is due to something other than the yielding ability of the varieties, as variable stand, variable soil, etc. Cv means coefficient of variation and the smaller it is the more reliable the test.

ORIGINAL SOURCES OF SEED

Auburn 56—Alabama Agri. Experiment Station, Auburn, Ala.

Auburn M—Foundation Seed Stocks, Columbia, Mo.

Carolina Queen and Coker 100A WR Coker's Ped. Seed Co., Hartsville, S.C.

DeKalb 108; 128; and 220—DeKalb Agri Assn., Inc., Bogart, Ga.

Deltapine 45; 45A, and Smooth Leaf—Delta & Pine Land Co., Scott, Miss.

Empire WR 61—Empire Ped. Seed Co., Haralson, Ga.

McNair 1032—McNair Seed Co., Laurinburg N. C.

Rex Smoothleaf—Cotton Branch Exp. Station Marianna, Ark.

Stoneville 213; 7A; 3202; and Dixie King II Stoneville Ped. Seed Co., Stoneville, Miss.

Delta; and Pennington Hy-Bee—Cotton Hybrid Research, Inc., Athens, Ga.

Three-year (63-64-65) average yields for nine hill section locations.

Variety	Lbs. lint per acre
Stoneville 213	919
Carolina Queen	913
Stoneville 7A	860
DeKalb 220	855
Stoneville 3202	851
Auburn 56	849
Coker 100A WR	840
Deltapine Sm Lf	833
Empire WR 61	831
Deltapine 45	830
DeKalb 108	829
Auburn M	821
Rex Smoothleaf	817

Brown Loam

3-Year Averages, Brown Loam Branch Station, Raymond

Variety	Yield, lbs. lint per A. 1963	1964	1965	Ave.	Acre value, dollars	Lint per-cent	Staple 32nds. inch	Bolls per lb.* Lint	Seed cotton	Pct. first picking
Empire WR 61	1477	868	1233	1192	407	35.7	34.8	155	55	72
Stoneville 213	1373	942	1201	1172	391	38.1	34.2	184	70	81
Carolina Queen	1133	885	1270	1096	364	38.2	34.6	170	65	82
Deltapine Sm. Lf	1175	842	1174	1064	357	37.2	34.3	199	74	82
DeKalb 220	1182	934	1015	1044	356	36.2	34.8	177	64	77
Auburn 56	1144	845	1122	1037	349	35.3	34.2	185	65	76
Stoneville 3202	1150	912	1032	1031	340	37.9	33.5	188	71	82
Deltapine 45	1120	890	1035	1015	338	37.7	34.3	187	70	80
DeKalb 108	1143	734	1138	1005	340	35.8	34.8	173	62	84
Rex Smoothleaf	1052	814	1037	968	326	35.7	34.3	171	61	82
Stoneville 7A	1014	820	992	942	311	38.2	34.1	178	68	72
Coker 100A WR	888	691	1114	898	298	36.6	34.5	184	67	79
Auburn M	1056	883	742	894	307	35.4	34.7	186	66	82

*2-year average.

Raymond, 1965

Variety	Yield per A., lbs. Seed cotton	Lint	Dollar val. per A., SLM	Lint pct.	Staple 32nds. inch	Bolls per pound Seed cotton	Lint	Pct. first picking
Dekalb 128	3835	1436	422	37.4	34.0	55	149	88
Carolina Queen	3297	1270	373	38.5	34.0	61	158	81
Empire WR 61	3439	1233	371	35.8	35.0	50	141	84
Delta Hy-Bee	3299	1232	370	37.3	35.0	59	158	83
Stoneville 213	3150	1201	353	38.1	34.0	66	174	80
Deltapine Sm. Lf	3167	1174	353	37.0	35.0	68	185	80
McNair 1032	3061	1144	329	37.3	33.3	67	180	70
DeKalb 108	3162	1138	342	36.0	35.3	58	161	85
Auburn 56	3189	1122	330	35.1	34.0	59	168	70
Coker 100A WR	2981	1114	327	37.3	34.3	61	164	76
Pennington Hy-Bee	2816	1053	309	37.4	34.0	58	156	78
Rex Smoothleaf	2940	1037	305	35.2	34.0	54	155	79
Deltapine 45A	2819	1036	305	36.7	34.7	67	183	72
Deltapine 45	2826	1035	304	36.6	34.3	68	187	81
Stoneville 3202	2750	1032	296	37.5	33.3	66	177	79
DeKalb 220	2788	1015	305	36.4	35.0	57	158	72
Dixie King II	2707	1006	289	37.1	33.7	51	139	73
Stoneville 7A	2585	992	291	38.3	34.0	64	168	71
Auburn M	2109	742	223	35.1	35.0	61	174	76
LSD @ 5%		245						
C.V.		19.2%						

Planted: April 30; Soil: Calloway silt loam; Fertilizer: 133-100-100; Poisoned: 11 times.

Coastal Plain

3-Year Averages, Coastal Plain Branch Station, Newton

Variety	Yield, lbs. lint per A.				Acre value, dollars	Lint per-cent	Staple 32nds. inch	Bolls per lb.		Pct. first picking
	1963	1964	1965	Ave.				Lint	Seed cotton	
Carolina Queen	1038	780	965	928	306	40.6	34.5	179	73	67
Stoneville 213	955	762	964	894	294	39.9	34.2	183	73	65
Rex Smoothleaf	967	785	848	867	290	39.2	34.5	166	65	68
DeKalb 220	977	643	932	851	286	38.1	35.0	184	70	64
Coker 100A WR	955	716	853	841	282	38.9	34.7	183	71	65
Auburn M	967	720	830	839	279	37.7	34.2	180	68	71
DeKalb 108	858	703	940	834	277	38.5	34.5	177	68	67
Stoneville 7A	866	738	854	819	273	40.0	34.7	188	75	63
Auburn 56	970	670	814	818	275	37.4	34.2	194	72	68
Deltapine Sm. Lf	878	844	715	812	271	39.3	34.4	211	83	65
Stoneville 3202	927	688	792	802	266	39.2	33.8	195	76	70
Deltapine 45	710	755	931	799	262	39.2	34.2	193	76	66
Empire WR 61	911	710	771	797	269	38.1	34.4	163	62	70

Newton, 1965

Variety	Yield per A., lbs.		Dollar val. per A., SLM	Lint pct.	Staple 32nds. inch	Bolls per pound		Pct. first picking
	Seed cotton	Lint				cotton Seed	Lint	
McNair 1032	2460	1007	289	40.9	33.7	74	183	78
Carolina Queen	2262	965	276	42.6	33.7	74	174	79
Stoneville 213	2296	964	282	42.0	34.3	71	169	76
Pennington Hy-Bee	2364	959	281	40.5	34.0	66	163	76
Dekalb 108	2338	940	276	40.2	34.7	68	170	78
Dekalb 128	2287	934	274	40.8	34.0	68	168	73
Dekalb 220	2327	932	273	40.0	34.7	68	169	77
Deltapine 45	2293	931	273	40.5	34.0	74	184	84
Delta Hy-Bee	2137	874	256	40.9	34.7	69	169	76
Stoneville 7A	2036	854	250	41.9	34.7	76	183	77
Coker 100A WR	2127	853	250	40.1	34.7	68	170	77
Rex Smoothleaf	2122	848	249	39.9	34.0	66	165	75
Deltapine Sm. Lf	2024	844	247	41.7	34.0	82	196	74
Auburn M	2114	830	238	39.2	33.7	65	167	79
Deltapine 45A	2024	827	248	40.8	35.0	72	178	72
Auburn 56	2092	814	239	38.9	34.0	68	175	77
Stoneville 3202	1951	792	227	40.6	33.0	75	186	80
Dixie King II	1896	772	221	40.7	33.7	58	143	79
Empire WR 61	1940	771	226	39.7	34.0	59	149	77
LSD @ 5%		NS						
C.V.		16.3%						

Planted: April 26; Soil: NA.; Fertilizer: 78-78-78; Poisoned 22 times.

Northeast Mississippi

3-Year Averages, Northeast Mississippi Branch Station, Verona

Variety	Yield, lbs. lint per A.				Acre value, dollars	Lint per-cent	Staple 32nds. inch	Bolls per lb.		Pct. first picking
	1963	1964	1965	Ave.				Lint	Seed cotton	
Auburn 56	551	803	900	751	246	36.9	34.2	184	68	None
Stoneville 7A	587	674	988	750	243	38.3	34.4	187	72	"
DeKalb 220	554	809	872	745	248	37.0	35.0	179	66	"
Deltapine 45	503	718	1011	744	240	38.7	34.1	191	74	"
Stoneville 3202	596	740	895	744	240	38.1	33.4	188	72	"
Deltapine Sm. Lf	489	803	922	738	239	39.8	34.1	194	77	"
Stoneville 213	499	773	934	735	239	37.7	34.2	191	71	"
Carolina Queen	430	779	957	722	233	38.6	34.3	175	67	"
Coker 100A	434	722	988	715	234	37.4	35.2	183	68	"
Empire WR 61	489	761	877	709	233	36.0	34.3	160	57	"
DeKalb 108	453	719	945	706	232	37.0	34.6	180	66	"
Rex Smoothleaf	389	775	762	642	211	36.0	34.2	174	63	"
Auburn M	403	734	709	615	202	37.3	34.5	179	66	"

Verona, 1965

Variety	Yield per A., lbs.		Dollar val. per A., SLM	Lint pct.	Staple 32nds. inch	Bolls per pound		Pct. first picking
	Seed cotton	Lint				Seed cotton	Lint	
Deltapine 45A	2569	1046	300	40.7	33.0	74	182	100
Dixie King II	2495	1017	291	40.7	33.3	61	150	100
Deltapine 45	2487	1011	290	40.6	33.3	78	191	100
Delta Hy-Bee	2490	1003	288	40.3	33.7	66	165	100
Coker 100A	2486	988	290	39.7	34.3	70	177	100
Stoneville 7A	2401	988	283	41.1	33.7	78	190	100
Carolina Queen	2364	957	274	40.5	33.7	75	185	100
DeKalb 108	2385	945	277	39.6	34.3	70	178	100
Stoneville 213	2273	934	268	41.0	33.0	73	178	100
DeKalb 128	2356	925	271	39.2	34.0	66	169	100
Deltapine Sm. Lf.	2240	922	270	41.1	34.0	80	196	100
Pennington Hy-Bee	2250	900	258	40.0	33.3	67	168	100
Auburn 56	2318	900	258	38.8	33.7	69	178	100
Stoneville 3202	2244	895	257	39.8	33.0	74	187	100
Empire WR 61	2292	877	252	38.2	33.3	57	148	100
DeKalb 220	2243	872	256	38.9	34.7	69	179	100
McNair 1032	2125	835	240	39.3	33.7	75	192	100
Rex Smoothleaf	1969	762	219	38.7	33.7	65	168	100
Auburn M	1828	709	208	38.7	34.3	68	177	100
LSD @ 5%		108						
C.V.		10.3%						

Planted: May 1; Soil: Loamy bottom; Fertilizer: 55-75-50; Times poisoned: Not available.

North Mississippi, Bottom Land

3-Year Averages, Bottom Land, North Mississippi Branch Station, Holly Springs

Variety	Yield, lbs. lint per A.				Acre value, dollars	Lint per-cent	Staple 32nds. inch	Bolls per lb.		Pct. first
	1963	1964	1965	Ave.				Lint	Seed cotton	
Carolina Queen	1067	1442	836	1115	371	40.8	34.8	157	64	74
Stoneville 213	1087	1317	906	1103	363	41.1	33.9	168	69	78
DeKalb 220	1012	1226	893	1044	354	38.7	34.8	159	61	76
Stoneville 7A	1009	1208	868	1028	343	40.2	34.7	180	72	72
Auburn 56	939	1143	887	990	327	37.4	33.6	176	66	78
Deltapine Sm. Lf.	951	1108	899	986	327	40.4	34.4	173	69	72
Coker 100A WR	990	1174	788	984	331	38.9	34.7	177	69	73
Deltapine 45	920	1207	804	977	321	39.5	33.6	168	66	75
DeKalb 108	913	1169	845	976	326	38.3	34.2	171	65	75
Stoneville 3202	924	1143	854	974	318	40.0	33.1	169	67	82
Auburn M	918	1179	816	971	325	36.7	34.1	173	63	81
Rex Smoothleaf	857	1104	824	928	308	37.9	33.8	155	58	78
Empire WR 61	832	1054	750	879	292	37.7	33.8	139	52	75

Bottom Land, Holly Springs, 1965

Variety	Yield per A., lbs.		Dollar val. per A., SLM	Lint pct.	32nds. 32nds. inch	Bolls per pound		Pct. first picking
	Seed cotton	Lint				Seed cotton	Lint	
Pennington Hy-Bee	2294	929	273	40.5	34.3	63	155	86
Stoneville 213	2170	906	259	41.7	33.0	73	175	91
Deltapine Sm. Lf.	2167	899	258	41.5	33.3	69	167	79
DeKalb 220	2217	893	256	40.3	33.3	62	155	86
Auburn 56	2283	887	248	38.8	32.3	68	175	88
McNair 1032	2177	871	250	40.0	33.3	65	164	84
Stoneville 7A	2085	868	249	41.6	33.7	72	174	90
Dixie King II	2132	864	241	40.5	32.3	56	139	85
Deltapine 45A	2035	855	238	42.0	32.7	74	177	85
Stoneville 3202	2070	854	238	41.2	32.0	73	178	91
DeKalb 128	2147	853	245	39.7	33.7	59	149	82
Delta Hy-Bee	2104	851	250	40.4	34.0	62	154	88
DeKalb 108	2096	845	242	40.3	33.3	70	175	87
Carolina Queen	2033	836	239	41.1	33.7	67	163	82
Rex Smoothleaf	2076	824	230	39.6	32.3	59	151	88
Auburn M	2127	816	234	38.3	33.7	67	176	87
Deltapine 45	1966	804	224	40.9	32.3	68	168	84
Coker 100A WR	1950	788	226	40.4	33.7	68	168	84
Empire WR 61	1890	750	215	39.6	33.0	54	138	88
LSD @ 5%		NS						
C.V.		14.8%						

Planted: April 30; Soil: Collins silt loam; Fertilizer: 72-48-48; Poisoned: 15 times.

North Mississippi, Hill Land

3-Year Averages, Hill Land, North Mississippi Branch Station, Holly Springs

Variety	Yield, lbs. lint per A. 1963	1964	1965	Ave.	Acre value, dollars	Lint per-cent	Staple 32nds. inch	Bolls per lb. Lint	Seed cotton	Pct first picking
Stoneville 213	788	1115	712	872	280	41.2	33.0	190	78	72
Auburn M	845	1108	644	866	284	39.8	33.4	184	73	78
Carolina Queen	797	1086	646	843	275	41.3	33.2	186	77	67
Auburn 56	779	1094	630	834	278	38.7	33.8	191	74	73
Stoneville 7A	820	1014	649	828	271	41.0	33.3	186	76	68
Rex Smoothleaf	797	1015	665	826	272	39.8	33.3	176	70	73
Stoneville 3202	745	1084	588	806	262	40.8	32.9	180	73	76
DeKalb 108	800	990	624	805	266	39.5	33.7	183	72	69
DeKalb 220	804	974	625	801	265	39.4	33.6	185	73	69
Coker 100A WR	750	1012	639	800	265	40.1	33.8	184	73	66
Deltapine Sm. Lf	685	936	613	745	245	40.0	33.4	198	79	67
Empire WR 61	661	975	600	745	244	40.7	33.7	166	67	66
Deltapine 45	651	972	577	733	238	40.7	33.1	186	75	64

Hill Land, Holly Springs, 1965

Variety	Yield per A., lbs. Seed cotton	Lint	Dollar val. per A., SLM	Lint pct.	Staple 32nds. inch	Bolls per pound Seed cotton	Lint	Pct first picking
Dixie King II	1748	719	206	41.1	33.0	72	177	84
Stoneville 213	1723	712	204	41.3	33.3	78	190	85
Pennington Hy-Bee	1648	682	195	41.3	33.0	78	189	88
Rex Smoothleaf	1653	665	191	40.2	33.0	75	187	87
Delta Hy-Bee	1580	651	187	41.2	33.3	85	206	82
Stoneville 7A	1521	649	186	42.6	33.3	83	196	86
Carolina Queen	1530	646	180	42.2	32.3	81	192	82
Auburn M	1614	644	184	39.9	33.0	78	196	90
Coker 100A	1580	639	183	40.4	33.0	81	202	84
Auburn 56	1615	630	181	39.0	33.3	81	207	86
DeKalb 220	1544	625	179	40.4	33.0	82	203	83
DeKalb 108	1545	624	179	40.4	33.7	80	199	84
Deltapine Sm. Lf	1462	613	175	41.9	33.0	92	220	76
Empire WR 61	1460	600	172	41.1	33.3	71	173	87
DeKalb 128	1486	598	171	40.2	33.3	78	195	84
Stoneville 3202	1443	588	164	40.7	32.3	81	199	88
Deltapine 45	1399	577	161	41.2	32.7	84	205	84
McNair 1032	1431	576	161	40.3	32.7	85	212	75
Deltapine 45A	1367	570	159	41.7	32.3	87	209	84
LSD @ 5%		63						
C.V.		10.2%						

Planted: April 30; Soil: Grenada silt loam; Fertilizer: 72-48-48; Poisoned: 10 times.

Pontotoc, Ridge

3-Year Averages, Pontotoc Ridge, Pontotoc Branch Station, Pontotoc

Variety	Yield, lbs. lint per A. 1963	1964	1965	Ave.	Acre value, dollars	Lint per-cent	Staple 32nds. inch	Bolls per lb. Lint	Seed cotton	Pct. first picking
Carolina Queen	1056	803	950	936	308	39.2	33.6	186	73	None
Auburn M	1039	869	798	902	297	37.9	33.2	178	68	"
Stoneville 3202	988	808	849	882	286	39.1	32.8	192	75	"
Auburn 56	939	873	810	874	290	37.0	33.6	186	69	"
Coker 100A WR	991	799	829	873	289	38.5	34.3	183	70	"
Stoneville 213	919	831	860	870	285	39.5	33.4	188	74	"
Rex Smoothleaf	949	747	912	869	287	38.2	34.1	164	62	"
Deltapine 45	913	783	901	866	285	38.6	33.9	193	74	"
Stoneville 7A	894	786	911	864	283	39.5	34.0	184	72	"
DeKalb 108	939	766	877	861	285	38.1	33.9	171	65	"
DeKalb 220	888	857	819	855	285	38.0	34.2	174	66	"
Empire WR 61	854	815	869	846	277	38.7	33.5	145	56	"
Deltapine Sm. Lf.	843	747	784	791	260	39.0	33.6	200	78	"

Pontotoc Ridge, 1965

Variety	Yield per A., lbs. Seed cotton	Lint	Dollar val. per A., SLM	Lint pct.	Staple 32nds. inch	Bolls per pound Seed cotton	Lint	Pct. first picking
Dixie King II	2589	1067	298	41.2	32.3	70	171	100
Carolina Queen	2346	950	265	40.5	32.0	87	215	100
Rex Smoothleaf	2206	912	254	41.3	32.0	71	173	100
Stoneville 7A	2222	911	254	41.0	32.3	80	196	100
Deltapine 45	2252	901	252	40.0	32.7	84	210	100
DeKalb 108	2188	877	245	40.0	32.0	73	183	100
Pennington Hy-Bee	2162	875	244	40.4	32.3	72	177	100
Delta Hy-Bee	2159	870	238	40.2	31.3	76	190	100
Empire WR 61	2089	869	237	41.6	31.3	60	145	100
Stoneville 213	2047	860	240	42.0	32.0	79	188	100
Deltapine 45A	2107	852	238	40.4	32.7	84	208	100
Stoneville 3202	2097	849	232	40.5	31.3	81	200	100
Coker 100A	2103	829	231	39.4	32.7	75	192	100
DeKalb 128	2040	822	230	40.3	32.7	76	190	100
DeKalb 220	2054	819	229	39.8	32.3	75	188	100
Auburn 56	2082	810	226	38.9	32.0	75	194	100
Auburn M	2059	798	218	38.7	31.3	74	191	100
McNair 1032	1968	793	213	40.3	30.7	82	204	100
Deltapine Sm. Lf.	1920	784	219	40.8	32.0	83	203	100
LSD @ 5%		100						
C.V.		10.3%						

Soil: Atwood; Fertilizer: 82-60-60; Planted: April 21; Poisoned: 8 times.

Pontotoc, Flatwoods

3-Year Averages, Flatwoods, Pontotoc Branch Station, Pontotoc

Variety	Yield, lbs. lint per A. 1963	1964	1965	Ave.	Acre value, dollars	Lint per-cent	Staple 32nds. inch	Bolls per lb. Lint	Seed cotton	Pct. first picking
Carolina Queen	789	760	752	767	254	39.0	34.3	174	68	None
Coker 100A WR	691	738	762	730	241	38.2	34.1	188	71	"
Auburn M	752	743	693	729	243	37.5	34.0	177	66	"
Stoneville 213	777	708	587	691	229	38.7	34.0	192	74	"
Empire WR 61	727	734	581	681	227	37.7	33.7	150	56	"
Auburn 56	710	659	638	669	222	37.2	33.8	186	69	"
Stoneville 3202	697	710	574	660	217	38.5	33.3	185	71	"
Rex Smoothleaf	718	628	601	649	216	37.2	33.7	168	62	"
Stoneville 7A	693	630	597	640	212	38.7	34.1	186	72	"
DeKalb 220	799	643	472	638	216	37.0	33.8	172	64	"
DeKalb 108	695	633	565	631	211	36.8	33.7	178	66	"
Deltapine 45	719	568	546	611	204	37.7	34.1	184	69	"
Deltapine Sm. Lf.	668	570	454	564	188	38.2	33.8	194	74	"

Flatwoods, 1965

Variety	Yield per A., lbs. Seed cotton	Lint	Dollar val. per A., SLM	Lint pct.	Staple 32nds. inch	Bolls per pound Seed cotton	Lint	Pct. first picking
Coker 100A	1938	762	223	39.3	34.0	74	190	100
Carolina Queen	1912	752	216	39.3	33.0	66	167	100
Auburn M	1814	693	203	38.2	34.3	66	173	100
Auburn 56	1676	638	183	38.1	33.7	63	165	100
McNair 1032	1616	624	174	38.6	32.7	69	180	100
Rex Smoothleaf	1563	601	172	38.4	33.0	65	170	100
Stoneville 7A	1504	597	171	39.7	33.7	70	178	100
Dixie King II	1578	593	174	37.6	34.0	62	167	100
Stoneville 213	1500	587	168	39.1	33.7	69	176	100
Empire WR 61	1507	581	167	38.5	33.3	56	145	100
Stoneville 3202	1496	574	165	38.3	33.7	68	177	100
DeKalb 108	1496	565	162	37.7	33.3	67	178	100
Pennington Hy-Bee	1406	546	156	38.8	33.7	59	152	100
Deltapine 45	1453	546	157	37.5	33.7	66	175	100
DeKalb 128	1408	534	153	37.9	33.3	70	186	100
Delta Hy-Bee	1337	529	155	39.5	34.0	63	160	100
Deltapine 45A	1377	516	148	37.4	33.3	67	179	100
DeKalb 220	1259	472	135	37.5	33.7	62	166	100
Deltapine Sm. Lf.	1175	454	130	38.6	33.7	70	181	100
LSD @ 5%		144						
C.V.		21.6%						

Planted, 3rd time: May 28; Soil: Bude; Fertilizer: 82-60-60; Poisoned 7 times.

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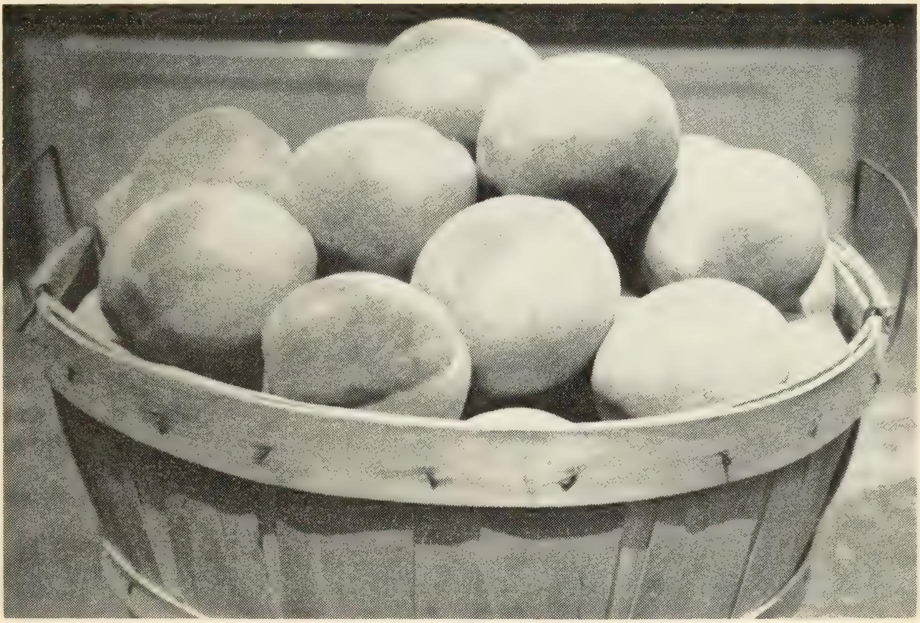
Peach Variety Evaluation In Mississippi



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On Cover:

Figure 4. A half bushel of peaches which are over three inches in diameter.

PEACH VARIETY EVALUATION IN MISSISSIPPI

BY J. P. OVERCASH

Mississippi commercial peach growers are annually faced with the decision of which peach varieties to plant as new orchards are planted and old orchards are expanded. Varieties are often described as the backbone of the fruit industry. The success of a peach growing enterprise always hinges on a wise choice of varieties.

Hundreds of varieties are available from which a grower must choose only one or a few. The number of peach varieties a grower should plant will depend on his objectives and the type of business he wishes to develop. If the peaches are to be sold at wholesale markets, the grower may prefer only a few varieties. Often less than six is desirable, in order that a grower may develop considerable volume of fruit of one variety. This permits advertising a particular variety and customers learn to identify and prefer the more desirable varieties.

In contrast, if the peaches are to be grown for sale at a roadside market, a large number of varieties may be planted. This permits the selection of varieties which may have characteristics which are desirable for local markets but might not be acceptable for wholesale markets. Therefore, these should not be included in larger acreages. Also, local markets sometime prefer a white-fleshed variety, such as Georgia Belle, which may not be suitable for large markets.

Thus, success in peach growing requires careful selection of varieties. A grower should carefully study all information available before making his choice.

Many new varieties are introduced every year by governmental agencies as well as private peach breeders and nurserymen. The peach breeders are making an effort to improve the existing varieties in many ways. One major objective is earlier ripening varieties with better fruit quality and freestone characteristics. Varieties with fruits with non-browning flesh are also being developed by breeding. This character greatly enhances the consumer acceptance of a variety for either fresh consumption or processing.

Susceptibility of peach varieties to prolonged winter dormancy is a character which must be avoided in the southern third of Mississippi. Fortunately, there are at least four peach breeding programs in the Southeastern United States in which adaptation to mild winter climate is a major objective. New varieties have recently been introduced which have short rest periods and require less than 600 chilling hours at 45°F. or lower during the winter in order to grow normally and produce fruit the following spring.

Since peach gowers are unable to test all of the new varieties which are named, the Mississippi Agricultural Experiment Station maintains variety test orchards to evaluate the usefulness of new varieties for the commercial growers. New varieties are added to the test orchards every year and old varieties which have not proven to be satisfactory are discarded. A few selections from peach breeders in nearby states are tested and when they are named, information on their local adaptation in Mississippi is available to growers at that time.

Orchard Care and Maintenance

The peach orchards at Mississippi State University are located on hillsides to provide air drainage for spring frost protection. Trees are planted on the contour with the tree rows about 27 feet apart with trees 23 feet apart in the row. Each tree row is built up to serve as a terrace for water dainage.

Fertilizers: The trees are fertilized twice annually beginning shortly after the newly set trees begin to grow. One half pound of 12-16-16 fertilizer is applied in a band 3 to 6 inches wide beginning 12 inches from the trunk. A second application of one half pound of 16 percent nitrogen or its equivalent is applied in June.

Older trees receive fertilizer twice annually. In late February or early March, before growth begins, an application of 12-16-16 fertilizer is made at the rate of one half pound and 16 percent nitrogen at the rate of one fourth pound per tree per year of age. In late June or July, after harvest, an additional nitrogen fertilizer application is made at the rate of one fourth pound of 16 percent nitrogen per tree per year of age. Trees which had been in the orchard one or more years received the fertilizer as a broadcast application extending from the tree trunk to a distance of about two feet beyond the ends of the limbs. For example, a six-year-old tree would receive 3 pounds of 12-16-16 fertilizer and one and one half pounds of 16 percent nitrogen in late February. In late June or early July an additional one and one half pounds of 16 percent nitrogen fertilizer would be applied.

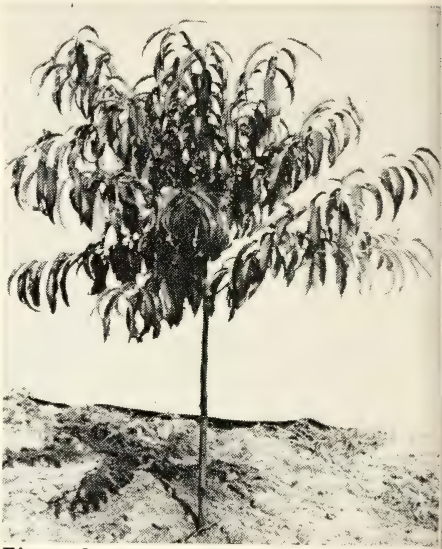

Figure 1. A peach tree in mid-July of it
first year in the orchard.

Peach fruits are produced from flower buds which are formed in the axils of the leaves on the previous season's growth. It is therefore desirable for the grower to manage the tree in such a manner that by mid-summer, there are a large number of new shoots which are 18 to 24 inches long which have a good diameter. The mid-summer supplemental nitrogen fertilizer application is made to provide adequate nutrition for the trees to mature the shoots following harvest o
the fruit. The trees should be manage
so that dark green foliage is maintaine
on the tree until late fall. However, succulent tree growth in the late summe
should be avoided to prevent damag
to the trees by early or very sever
freezes before the trees are fully winte
hardened.

Pruning: The trees are trained th
first summer and thereafter to the ope
center system. Three to five main scaffold limbs are selected during the firs
summer at a height of two to three fee
above the ground and well distribute
around the trunk (see figure 1). The secondary limbs are selected to give a wel
balanced tree and the open center i
maintained to develop good color an
size of fruit inside the tree.

When the trees begin to bear they ar
pruned annually at a moderate leve
About one third of the previous season
growth is removed as illustrated in Figure 2 for four-year-old trees. This permits heavy fruit production, yet the ne
shoot growth is adequate to provide fo
next year's crop production. Figur

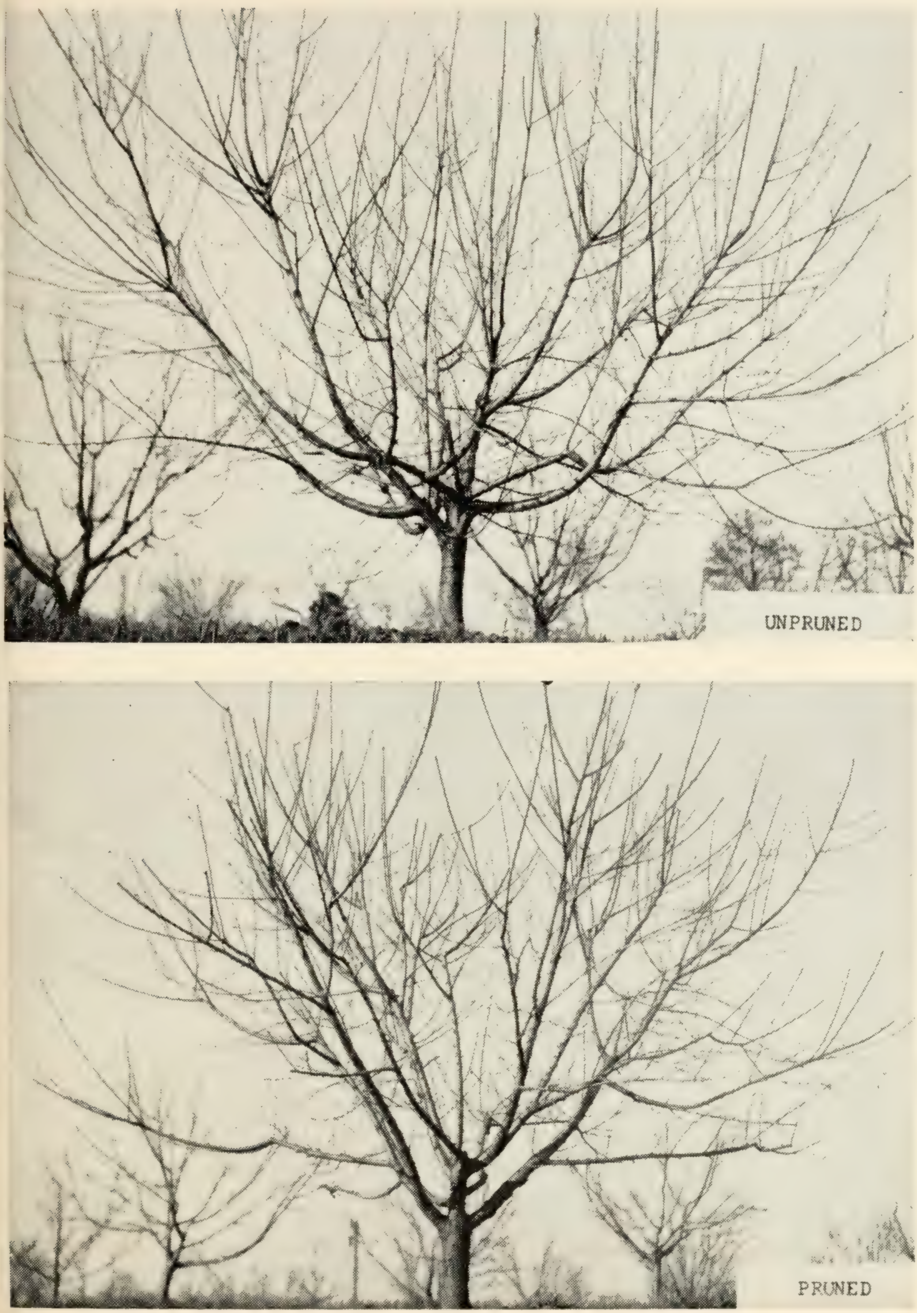
UNPRUNED
PRUNED

Figure 2. Four year old peach trees before and after pruning.

3 shows a healthy three-year-old tree with good vigor which is capable of heavy fruit production.

Thinning: When severe winter freezes (0°F. or lower) do not occur or spring frosts do not kill the flower buds, the peach trees develop and set more fruits than the trees are capable of maturing with adequate fruit size. The normal healthy twigs may have as many as 6 to 20 blossoms per foot of twig growth. Even under favorable conditions, many of these blossoms fail to set fruit. If the fruits are too thick on the twigs, they should be thinned so that at maturity, they do not touch each other. Ordinarily, a spacing of 4 to 6 inches between fruits is satisfactory. When the tree is vigorous and the fruits are spaced properly, large fruits as shown in Figure 4, are produced.

Fruits should be thinned as soon after blossoming and fruit-set as is feasible for the orchard operation. Early ripening varieties respond best to early thinning of fruits. The severity of thinning should be regulated to develop the size of peaches desired by the grower. In general, the more severe the thining, the larger the fruits will be. Thinning should be completed shortly after the so called 'June drop".

Pest Control: Insects and diseases are controlled in the variety test orchards by regular control measures. The trees are treated with Di-Chlor-Mulsion in October or early November for the control of peach tree borers. An application of oil emulsion spray is made during the dormant season to control scale insects. This spray should be applied when the night temperature are above freezing.

The summer sprays begin at full bloom and continue at intervals of 10 days to

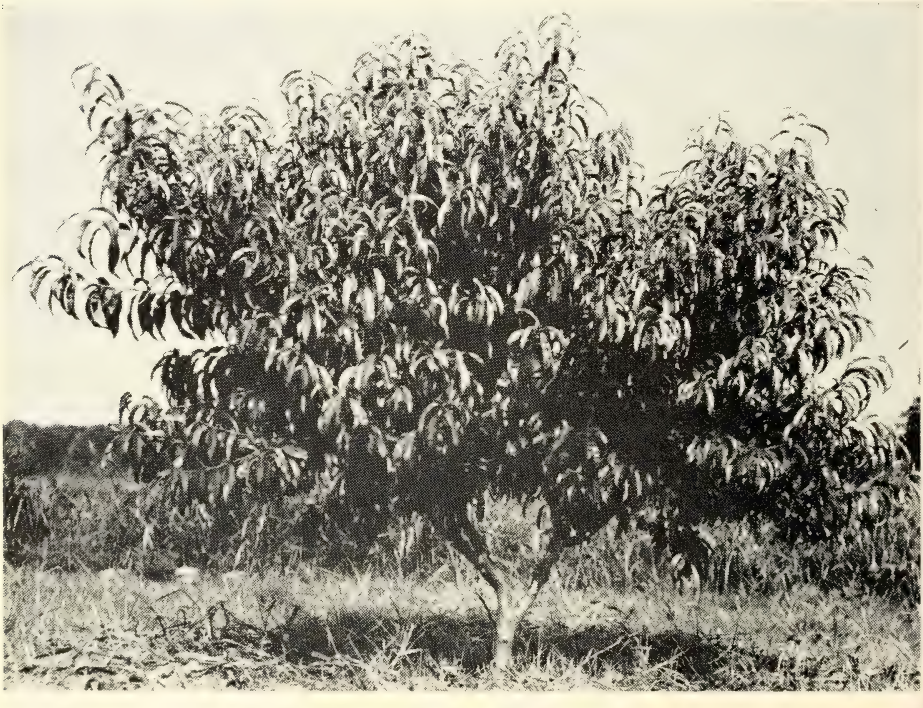

Figure 3. A vigorous Redhaven peach tree which was 9 feet wide in mid-July of its third summer in the orchard.

two weeks until just before harvest. They include insecticides for the control of plum curculio and other insects as well as fungicides for the control of brown rot, scab, and other diseases. For complete details on pest control of peaches, refer to the spray recommendations of the Cooperative Extension Service.

Harvesting: Fruits of each variety were harvested two or more times each year. The fruits were left on the tree until they were fully mature as indicated by changes in the ground color (the unblushed part) of the fruit. Consumer demands now require tree ripe mature fruits which have not softened too much to cause bruising from normal handling. Fruits increase in size until they are fully ripe therefore, harvesting green fruits seriously reduces the total yields.

The number of fruits per bushel varies inversely with the diameter as shown in table 1. A bushel of ripe peaches weighs approximately 50 pounds. Except for very early ripening varieties, there is little demand for peaches of 2 inch or smaller diameter.

TABLE 1: The influence of peach fruit diameter on the number of peaches per bushel

Diameter — Inches	Peaches per bushel
2	380
2 1/4	280
2 1/2	190
2 3/4	145
3	110

Results

Table 2 presents in tabular form the yield data for 86 varieties from 1960 through 1965 with the exception of 1962 which was almost a total crop failure due to severe winter freezes and late frosts in the spring.

Dates of First Harvest: Twelve varieties which produced fruit for five years were used to determine differences in average dates of ripening between years. The average dates of ripening for varieties which were not harvested all five years were adjusted according to the average date for the years involved. There were 18 days variation between the earliest and latest average dates of first harvest for these 12 varieties between years.

The ripening season for a variety is of utmost importance to a grower, who must decide which part of the season should receive his attention. Many growers do not want to cover the entire season of 10 weeks as represented by the May 24 to August 4 dates shown for the varieties in table 2.

Prospective growers should be aware of the fact that the quality of the fruits of varieties which ripen very early is generally not as good as varieties which ripen later in the season. Furthermore, most of the very early varieties have flesh which clings to the pit or stone. This fruit characteristic is generally undesirable. In fresh markets where clingstone varieties compete with freestone varieties, the freestone varieties bring a premium price.

Appearance: Peaches are often bought on impulse by the consumer, therefore, color and size of the fruits are of considerable importance to the producer as well as the retail merchant.

The fresh peach markets generally prefer a fruit with highly colored red skin Fruits with yellow flesh are also preferred. Variations in pecentages of the skin colored red between varieties was from a low of 20 to a high of 95 for the varieties tested. However, a grower could not safely select a variety simply because it has a bright red skin. Many other factors should be considered.

Attractiveness was the principle point considered in judging consumer appeal in this study. A score of 6.0 was barely acceptable for market purposes. Size of fruit, amount of red skin color, brightness of colors, and uniformity of shape influenced the evaluation of varieties for attractiveness.

On each harvest date 20 fruits of each

TABLE 2. Fruit Records for Peach Varieties from 1960 to 1965 at Mississippi State University.

Ave. date first harvest	Variety	Number years fruited	Number fruits per bushel	Percent skin colored red	Attractiveness 9 - Exc. 6 - Poor	Stone freeness	Flesh color	Juice—percent soluble solids	Flavor
May 24	Earligold	4	285	70	6.5	Semi	Yellow	13.4	Good
May 24	Springtime	3	212	75	7.0	Cling	White	12.5	Fair
May 26	Marcus	2	238	45	6.0	Cling	Yellow	11.5	Fair
May 28	Redwin	4	232	35	6.0	Semi	White	12.1	Fair
May 29	Mayflower	3	337	65	6.0	Cling	White	11.7	Fair
June 1	Red Robin	4	238	95	6.9	Cling	White	13.5	Fair
June 4	June Gold	5	193	50	7.2	Cling	Yellow	11.4	Good
June 6	Earlired	5	243	80	7.3	Semi	Yellow	11.2	Fair
June 7	Red Bird	4	188	60	6.3	Cling	White	11.2	Fair
June 10	Collins	2	240	85	7.0	Cling	Yellow	14.2	Good
June 10	Dawne	3	270	50	6.3	Semi	Yellow	10.5	Good
June 11	Goldray	2	294	40	6.0	Semi	Yellow	12.2	Fair
June 12	Dixired	5	212	80	6.9	Cling	Yellow	12.9	Fair
June 12	Gold Dust	2	333	95	5.7	Semi	Yellow	14.2	Good
June 12	Hiland	2	303	80	6.0	Cling	Yellow	10.6	Excellent
June 13	Cardinal	3	390	85	5.9	Cling	Yellow	12.3	Fair
June 13	Maygold	3	289	80	5.9	Semi	Yellow	11.9	Fair
June 14	Blazing Gold	4	292	95	6.6	Semi	Yellow	12.2	Good
June 14	Redcap	3	285	90	6.1	Semi	Yellow	13.6	Fair
June 15	Erly-Red-Fre	4	206	55	7.4	Semi	White	13.1	Good
June 16	Stark Earliglo	2	333	70	6.0	Semi	Yellow	9.7	Fair
June 18	Coronet	5	212	70	7.0	Semi	Yellow	13.5	Good
June 18	Sunhaven	5	199	65	6.8	Cling	Yellow	10.1	Fair
June 22	Dixigem	5	238	55	6.7	Free	Yellow	12.1	Good
June 22	Garnet	2	227	70	6.5	Semi	Yellow	14.8	Good
June 22	Regina	2	227	60	7.5	Free	Yellow	13.4	Good
June 23	Comanche	2	235	45	6.5	Semi	Yellow	12.6	Good
June 23	Sam Houston	3	196	75	7.3	Free	Yellow	12.5	Good
June 23	Sunrise	4	285	80	6.4	Semi	Yellow	12.4	Good
June 24	Goldgem	3	376	50	7.0	Free	Yellow	11.6	Fair
June 24	Magill Hardy	2	212	20	6.0	Free	Yellow	11.6	Fair
June 27	Golden Jubilee	5	256	35	6.2	Free	Yellow	11.6	Good
June 27	Ranger	4	240	55	6.7	Free	Yellow	12.2	Fair
June 29	Lexington Nect	1	416	90	7.0	Free	Yellow	11.5	Good
June 29	Keystone	4	178	70	7.6	Semi	Yellow	13.5	Good
June 30	Redhaven	5	222	80	7.1	Free	Yellow	12.3	Excellent
July 1	Early Hale	3	151	35	6.6	Free	Yellow	12.6	Good
July 1	Goldenred	3	142	40	7.2	Semi	Yellow	11.2	Excellent
July 1	Merrill Goldrush	1	142	30	7.0	Free	Yellow	13.5	Good
July 2	Redglobe	4	182	65	7.0	Free	Yellow	12.8	Good
				55	7.0	Free	Yellow	12.0	Good

July 3	Suwanee	1	198	70	6.9	Free	Yellow	10.7	Fair
July 4	Ben Owens	2	232	45	5.0	Free	Yellow	9.0	Fair
July 4	Saturn	2	176	20	7.3	Cling	Yellow	13.2	Fair
July 4	Summerqueen	2	170	50	7.5	Free	Yellow	12.3	Good
July 4	Sunhigh	2	246	80	7.9	Semi	Yellow	12.3	Excellent
July 4	Triogem	4	232	55	7.5	Free	Yellow	12.6	Good
July 4	Washington	2	142	60	7.5	Free	Yellow	13.1	Excellent
July 5	Double Delight	3	210	45	6.9	Cling	Yellow	10.7	Good
July 5	Redbud Nect.	2	454	90	6.0	Semi	White	14.7	Excellent
July 5	Stark Redgold	4	147	65	7.6	Free	Yellow	11.8	Good
July 5	Southland	5	138	60	7.3	Free	Yellow	12.7	Good
July 6	Fireball	4	196	60	6.9	Free	Yellow	13.5	Good
July 6	Richhaven	4	142	50	7.1	Free	Yellow	12.2	Good
July 6	Southern Glow	4	263	60	6.9	Free	Yellow	12.7	Good
July 7	Ambergem	3	344	45	6.1	Cling	Yellow	10.2	Good
July 8	Blake	4	223	55	6.4	Free	Yellow	12.9	Fair
July 8	Loring	5	161	45	7.2	Free	Yellow	12.5	Excellent
July 9	Halehaven	4	188	65	7.2	Free	Yellow	11.7	Good
July 11	Burbank July Elb.	3	208	50	6.4	Free	Yellow	13.2	Good
July 11	Sullivans Ea. Elb.	5	172	40	6.8	Free	Yellow	11.4	Good
July 12	Daroga	2	206	50	7.1	Free	Yellow	11.1	Good
July 14	Red Chief Nect.	1	238	90	8.0	Semi	White	13.0	Good
July 16	Sunday Elberta	2	192	35	6.5	Free	Yellow	12.7	Good
July 18	Cavalier Nect.	1	357	80	8.0	Free	Yellow	12.5	Excellent
July 18	Curlew	1	312	30	6.0	Free	White	12.0	Good
July 18	Halberta Giant	1	192	30	7.0	Free	Yellow	9.0	Good
July 18	Nectaheart Nect.	1	303	95	8.0	Free	White	13.0	Excellent
July 18	Poppy	3	175	65	7.0	Semi	Yellow	14.2	Good
July 19	Alamar	2	161	30	6.5	Free	Yellow	12.0	Good
July 19	Hale Harrison	2	194	35	7.3	Free	Yellow	12.7	Good
July 20	Georgia Belle	4	211	30	6.2	Free	White	12.0	Good
July 20	Golden Elberta Cl.	2	176	20	6.5	Cling	Yellow	13.5	Fair
July 20	Honey Hale	1	172	20	6.0	Free	White	11.5	Good
July 23	Stark Lategold	4	146	45	5.5	Free	Yellow	13.0	Good
July 24	Elberta	5	172	40	6.6	Free	Yellow	12.3	Good
July 24	Kimbo	2	131	30	6.5	Free	Yellow	12.7	Fair
July 24	Redskin	3	175	55	6.7	Free	Yellow	11.9	Good
July 26	Jefferson	3	142	45	7.2	Free	Yellow	11.5	Good
July 27	Freedom Nect.	1	212	90	8.2	Free	Yellow	19.5	Excellent
July 27	Rio Oso Gem	4	172	40	6.6	Free	Yellow	10.2	Fair
July 29	Douthit Cling	1	192	30	6.0	Cling	Yellow	11.5	Fair
July 31	Palomar Nect.	1	357	65	5.3	Semi	Yellow	19.3	Fair
Aug. 2	Afterglow	4	212	60	7.0	Free	Yellow	13.0	Good
Aug. 2	Autumn	2	208	25	6.0	Free	Yellow	15.5	Excellent
Aug. 4	Frank	3	238	50	5.8	Cling	Yellow	12.6	Fair

variety were weighed and these figures were averaged for years and then were converted to peaches per bushel. Wide variations in number of peaches per bushel have occurred because of the influence of temporary droughts during one part of a season. These figures do not represent the absolute abilities of these varieties to produce large fruits under more ideal soil and growing seasons.

Eating Qualities: The fruits of each variety were sampled organoleptically at each harvest date. The flavor was rated numerically and converted to fair, good, or excellent as summarized in table 2. It may be noted that varieties shown to have excellent flavor did not always have high soluble solids.

The soluble solids were determined by using the juice from tree ripened fruit in a Bausch and Lomb juice refractometer The flavor and taste of a peach was influenced by the texture of the flesh as well as by the soluble solids and acids present.

Recommendations

The selection of varieties for large commercial plantings should receive careful consideration. If the orchard is to be located in south Mississippi, the varieties should have a relatively short chilling requirement and these are so indicated in table 3.

Growers for roadside or local market sales may plant many varieties with overlapping ripening season. Even for these markets the grower may want to concentrate the bulk of his production after midseason in order to have the best quality fruit.

There are many varieties including nectarines in table 2 which are not recommended for use by peach growers in Mississippi. Some of the reasons include poor appearance, soft fruits, uneven ripening, irregular fruit shapes and poor eating qualities.

Peach growers who want additional information on these or other peach varieties may write the Department of Horticulture, Mississippi Agricultural Experiment Station, State College Mississippi. Help can be provided in selecting varieties adapted for use in various parts of the state.

TABLE 3: Peach varieties and their recommended usage in Mississippi

Variety	Date	Commercial	Limited Trial	Adapted in South Miss.
Springtime	May 24		X	X
June Gold	June 4		X	X
Earlired	June 6		X	
Dixired	June 12	X		
Maygold	June 13	X		X
Erly-Red-Fre	June 15		X	
Dixigem	June 22		X	
Sam Houston	June 23		X	X
Ranger	June 27		X	
Keystone	June 29		X	X
Redhaven	June 30	X		
Goldenred	July 1		X	
Suwanee	July 3		X	X
Sunhigh	July 4		X	X
Triogem	July 4	X		
Southland	July 5	X		X
Loring	July 8		X	
Halehaven	July 9	X		
Sullivans Ea. Elb.	July 11	X		
Georgia Belle	July 20		X	
Elberta	July 24		X	
Redskin	July 24		X	
Rio Oso Gem	July 27		X	
Afterglow	August 2		X	

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1966 Crop and Fertilizer Recommendations For Mississippi

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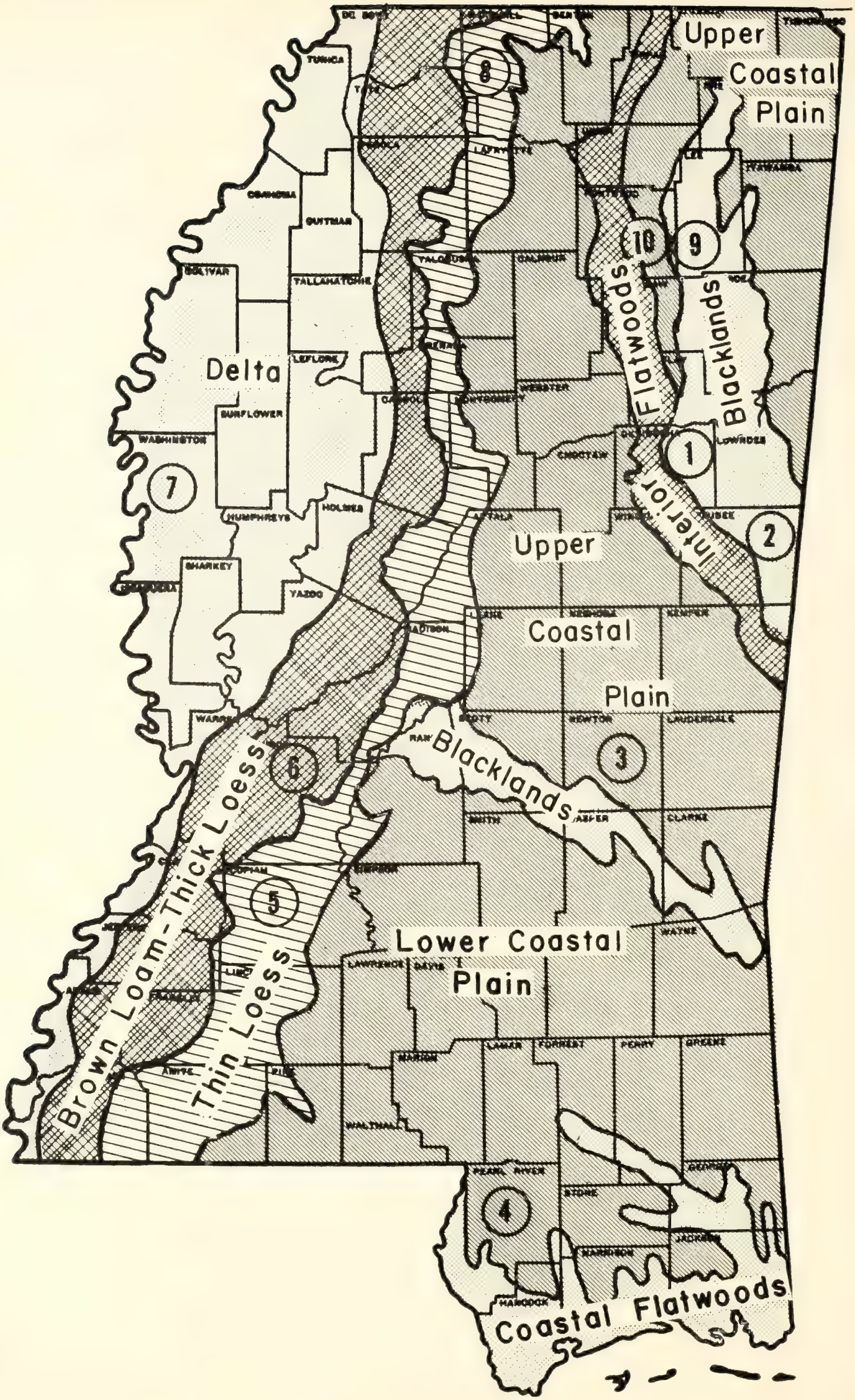
Upper
Coastal
Plain
8
10
9
Flatwoods
Blacklands
Delta
1
Interior
7
2
Upper
Coastal
Plain
3
Blacklands
6
Brown Loam-Thick Loess
5
Thin Loess
Lower Coastal
Plain
4
Coastal Flatwoods
DE SOTO
MARSHALL
BENTON
TISHOMINGO
TUNICA
TATE
PANOLA
LAFAYETTE
LEE
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COAHOMA
QUITMAN
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BOLIVAR
TALLAHATCHIE
YALOBUSHA
CALHOUN
LEFLORE
GRENADA
SUNFLOWER
CARROLL
MONTGOMERY
WEBSTER
WASHINGTON
OKTIBBEHA
LOWNDES
CHOCTAW
HOLMES
HUMPHREYS
ATTALA
WINSTON
NOXUBEE
SHARKEY
ISSAQUENA
YAZOO
LEAKE
NESHOBA
KEMPER
MADISON
SCOTT
NEWTON
LAUDERDALE
SMITH
JASPER
CLARKE
COPIAH
SIMPSON
WAYNE
LAWRENCE
DAVIS
FRANKLIN
AMITE
PIKE
MARION
LAMAR
FORREST
PERRY
GREENE
WALTHALL
PEARL RIVER
STONE
GEORGE
JACKSON
HARRISON
HANCOCK

CROP AND FERTILIZER RECOMMENDATIONS FOR MISSISSIPPI

At timely intervals the Mississippi Agricultural Experiment Station issues crop and fertilizer recommendations based on the latest research findings at State College and nine Branch Experiment Stations in the State. Included is information on ferilization, varieties, and rates of seeding for crops generally grown in Mississippi as well as information pertaining to lawns, turf grasses and home gardens.

Because of varying soil and weather condition and other local factors, no single crop variety or fertilizer will fit the entire state perfectly; nonetheless, these general recommendations are useful guides to crop production. Of course these recommendations assume that other good farming practices will be followed.

Details and qualifications are omitted in most cases; if you need information on any crop you may obtain it from the Extension Service, the Experiment Station, your County Agent, or other trained agricultural workers in you locality.

Soil Testing Service

The farmer realizes maximum profits from his fertilizer dollar only when the right kind and amount of fertilizers are used on each field. Through the Mississippi State Soil Testing Service every farmer can get detailed information about how much and what kind of fertilizer and lime to apply to each field. Furthermore, the Soil Testing Service makes fertilizer and lime recommendations for exceptionally high production goals and for contest fields which are not provided for in the general recommendations.

Soil testing is a free service. Soil sample boxes, mailing cartons, and instructions for collecting samples are available in each county agent's office and the offices of other agricultural agencies.

Plant Nutrients

Plant nutrients can be divided into two groups: (1) Those elements used by crops in relatively large amounts; and (2) those needed in very small amounts.

The first group includes nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. The first three of these are usually called the "fertilizer nutrients" and are often applied to crops either as straight materials or mixed fertilizers. Straight materials are those which contain only one fertilizer nutrient. Some examples of straight materials are listed below:

Material	Total Nitrogen (N)
Ammonium nitrate	33 1/3%
Anhydrous ammonia	82%
Nitrate of soda	16%
	Available Phosphate (P_2O_5)
Superphosphate	18 to 20%
	Available Potash (K_2O)
Muriate of Potash	60%

Mixed fertilizers contain two or more of the fertilizer nutrients, and each fertilizer bag is labeled with a set of numbers to show how much plant food it contains. The first number always shows the percentage nitrogen (N),the second represents the percentage available phosphate (P_2O_5), and the third shows percentage water-soluble potash (K_2O). One hundred pounds of a 5-10-10 fertilizer thus contains 5 lbs. of total N, 10 lbs. of available P_2O_5, and 10 lbs. of available K_2O. The fertilizer **ratio** refers to the relative amounts of these nutrients. The fertilizer **grade** gives the specific amounts of each fertilizer nutrient it contains. For example 8-8-8- and 10-10-10 are two different grades in a 1-1-1 ratio. Similarly, 6-8-8 and 9-12-12 are two grades in a 3-4-4 ratio.

At present fertilizer nutrients are expressed sometimes as the oxide, phosphorus as phosphorus pentoxide (P_2O_5) and sometimes as the element, nitrogen as N. As indicated before the primary "fertilizer nutrients" are shown on the fertilizer bag as N-P_2O_5-K_2O, but there is a move toward expressing all fertilizer nutrients on the elemental basis. Accordingly phosphate would be expressed as (P) and potash as (K) using the elemental symbols for phosphorus and potassium, respectively. The primary "fertilizer nutrient" when listed on the elemental basis would be given as N-P-K on the fertilizer bag. Some fertilizers are labeled both on the oxide and the elemental basis to familiarize consumers with the new labeling trend. When labeled on an elemental basis a 10-20-20 (N-P_2O_5-K_2O) would become a 10-8.7-16.5 (N-P-K). The conversion factors for potash are: K_2O x 0.86 = K; K x 1.21 = K_2O. The conversion factors for phosphate are: P_2O_5 x 0.436 = P; P x 2.29 = P_2O_5. Only the method of labeling is changed not the plant nutrient value of the fertilizer.

For the most part fertilizer recommendations are given in this circular as pounds of N, P_2O_5, and K_2O needed per acre. Usually the farmer will have a choice of more than one fertilizer grade. For example, 48 lbs. N, 48 lbs. P_2O_5, and 48 lbs. K_2O may be supplied with 600 lbs. of 8-8-8 or 400 lbs. of 12-12-12. Cost per unit of fertilizer and ease of handling should determine form and grade used. Since small deviations from the general recommendation will not affect profits significantly, it is not necessary to apply exactly the amounts of N, P_2O_5, or K_2O called for. If, in the case described above, only a 10-10-10 were available, the farmer should use 500 lbs. per acre thus giving a total of 50 lbs. of each nutrient.

Mixed fertilizers are available both in solid and liquid forms. Liquid fertilizers have been found to be excellent but they are no more effective than many, if not most, solid mixed fertilizers. Where there is a difference, it almost always occurs because of a variation in the effectiveness of the phosphate component. This is because only highly water soluble sources of nitroten and potash are generally employed in the formulation of both solid and liquid mixed fertilizers, but the water solubility as well as other characteristics of the phosphate materials in solid mixed fertilizers may vary widely. All highly water soluble phosphates are very effective phosphatic fertilizers but all phosphates of low water solubility are not.

In solid mixed fertilizers formulated with the ammonium phosphates or with non-ammoniated ordinary and concentrated superphosphates, a high percentage of the phosphate is water soluble and these fertilizers are just as effective as liquid mixed fertilizers. On the other hand; if the superphosphates are ammoniated to add nitrogen during the formulation of mixed fertilizers, which is a common practice, the water solubility of the phosphate is reduced and, in the case of ordinary (20%) superphosphate after the addition of a small amount of ammonia (2%), the effectiveness of the phosphate is reduced progressively with increasing ammoniation. This is because much of the highly effective, water-soluble monocalcium phosphate is changed into a much less effective water-insoluble, apatite-like calcium phosphate. In a sense new rock phosphate is formed. Consequently, solid mixed fertilizers containing highly ammoniated ordinary super phosphate are not as effective as liquid mixed fertilizers.

Farmers can be reasonably sure of good results if 50 to 60 percent of the "available" phosphorus is also soluble in water. Some manufacturers list water-soluble phosphorus content of their fertilizers though this is not required by law.

Because potassium sulfate is less soluble in water than either potassium nitrate or chloride, sulfate salts are not usually employed in the production of liquid mixed fertilizers. Therefore, these fertilizers may not contain sulfur which is recommended generally for most crops in the Hill areas of Mississippi.

Because of the insolubility of most calcium and magnesium phosphates, liquid mixed fertilizers do not contain appreciable quantities of calcium and magnesium. This is not considered to be of particular significance, however, because with few exceptions, calcium and magnesium should be added to soils as liming materials.

Practically all of the solid mixed fertilizers sold in Mississippi are formulated with either the ammonium phosphates or the superphosphates (both ammoniated and non-ammoniated) depending upon whether the fertilizer contain nitrogen. With these phosphatics, unfortunately, most of the apatite-like phosphates formed upon ammoniation of superphosphate are classified as "available" by the chemical methods currently used for control purposes and are so indicated on the fertilizer bag.

Calcium is usually applied to crops as agricultural limestone although the primary purpose of liming soils is to correct soil acidity by raising the pH. A more complete discussion of lime and liming is found elsewhere in this article. Magnesium may also be supplied in "dolomitic" limestone or, on soils needing magnesium but not requiring lime, as a soluble source of magnesium such as Sul-Po-Mag. Magnesium deficiences have been found so far only in parts of the Black Land Area of Mississippi.

Sulphur is an incidental component of superphosphate and is also contained in ammonium sulfate; therefore, when these materials (or mixed fertilizers formulated from these materials) are applied, sulfur is also added to the soil. However, changes in fertilizer technology have made possible the manufacture of fertilizer materials and mixtures containing very little sulfur. Research has shown that deficiencies are likely to occur on soils of the Hill Section when sulfur is omitted from the fertilizer program. Accordingly, mixed fertilizers containing sulfur are recommended, especially for cotton and legumes. Instances of deficiency have also occurred in the Delta. Sulfur deficiences have been associated with land leveling in some cases, but they are not restricted to the areas which have been leveled. Sulfur deficiencies can be corrected by applying gypsum or by using superphosphate, ammonium sulfate, or mixed fertilizers that contain sulfur.

The **second group** of nutrients is called "trace" or "minor elements" or "micronutrients" because they are needed by crops in very small amounts. Included are zinc, boron, iron, maganese, copper, and molybdenum. Except for boron on alfalfa and for seed production of such legumes as white and crimson clover, zinc under tung and pecan trees, and boron on cotton in the Hill Section, minor element deficiencies are not wide-spread in Mississippi. Of course, small isolated problem areas may exist throughout the state. For advice about suspected minor element problems, the farmer should contact his County Agent.

Soil pH and Liming

Excess soil acidity or a deficiency of lime reduces crop yields. A recent survey made by the Mississippi Soil Testing Laboratory showed that 68 percent of the soils tested needed lime.

The degree of acidity or alkalinity of a soil is expressed by the pH scale; values below 7.0 indicate an acid soil, above 7.0 an alkaline soil. Soil reaction, or pH, affects the availability of some of the more important plant nutrients in the soil. Phosphate is much less available in very acid soils than in slightly acid to mildly alkaline soil. In very strongly acid soils, (pH below 5.0) certain elements such as manganese and aluminum are changed to available forms in such quantities as to become toxic to plants. Essential plant nutrients such as iron, manganese, boron, and zinc rapidly become less available as the pH of the soil increases above 7.0. This is one reason why one must not overlime. Experience has shown that overliming injury in Mississippi is very likely to be associated with deficiencies of boron and zinc. In the case of cotton and legumes, it is very likely to be due to boron deficiency and with corn, and perhaps other grasses, to zinc deficiency.

It has been found that soils with a pH of 6.0 or higher are well supplied with lime and at the same time maintain the other nutrients in forms sufficiently available to crops. If the pH is less than 5.0, the soil is very strongly acid and is extremely deficient in lime. Most non-legumes grow best if the soil pH is not allowed to drop much below 5.5 while most legumes do best if the pH is maintained above 5.5. Alfalfa grows best at soil pH values above 6.0.

The amount of lime required to raise the pH of the soil to a desired value depends on both the initial pH and the lime holding capacity of the soil. On soils of Mississippi having a pH of 5.5 or slightly below, the application of 3000 pounds of lime per acre to sandy loam and loam soils, 5000 pounds to silt loam soils, and 7000 to 9000 pounds to clay loam and clay soils has been found to give satisfactory results in correcting lime deficiency for legumes. Since about two-thirds of the soils of the state have natural pH values of 5.5 or above, applications of the above rates of lime would bring or maintain the pH of a large majority of the soils within the range that is very favorable for legumes. But where such a program is followed, too much lime will be added to some soils and not enough to others. For example, the black upland soils and the bottom soils of the Northeast Blackland area seldom need lime even for legumes. A better practice would be to initiate a soil testing program on each farm and sample each field at least once in five years. Whenever the soil pH drops to an unfavorable level, the Soil Testing Laboratory will make specific recommendations as to the amounts of lime required.

It is a better practice to mix lime thoroughly with the top five to six inches of the soil, but depending on the texture 1000 to 2000 pounds may be applied as a surface application to permanent pastures, or other permanent sods.

Lime is naturally lost from the soil by crop removal and by leaching. The use of acid forming sources of nitrogen and the turning under of legumes as soil builders accelerate these losses. For example, 100 pounds of nitrogen from such sources as ammonium nitrate, anhydrous ammonia and urea will cause the loss of calcium and other bases equal to about 200 pounds of lime. When applied annually at this rate, the loss would amount to one ton of lime every ten years due to fertilizer alone. This, together with natural losses indicates that soils require lime at periodic intervals.

Generally, on sandy loam, loam, and silt loam soils a maintenance application of one ton of lime per acre once every 5 to 7 years will be required for legumes and for non-legumes fertilized with nitrogen as recommended. On clay loam and clay soils less frequent but larger applications may be made. Although lime may be needed badly on some soils for non-legumes, the deficiency is not sufficiently general to warrant a recommendation for its general use to raise the soil pH values to a more favorable range but maintenance applications should be made as indicated before to prevent more soils becoming deficient. Areas going into permanent grass sod should receive the initial maintenance application of lime prior to establishment. Subsequent maintenance applications may be applied to the surface.

The principal liming materials available in Mississippi are ground calcic and dolomitic limestones, cruched chalk or marl from Mississippi deposit and basic slag. Calcic limstones contain calcium carbonate while dolomitic limestones contain both calcium and magnesium carbonates. Liming materials from Mississippi deposits contain calcium carbonate only. Basic slag, a material containing a minimum of 6 percent P_2O_5 and the equivalent of about 75 percent lime is priced largely on the basis of its phosphate content, and should be used only where both the lime and phosphate are needed. The cost for its use as a liming material only is prohibitive.

Research has shown that all these materials are very effective in neutralizing soil acidity providing the calcic and dolomitic limestones have been finely ground. Particles not passing a 40-mesh screen (40 holes per linear inch) are not very effective in neutralizing soil acidity. For this reason 90 to 100% of calcic and dolomitic limestones should pass a 10-mesh screen and 50% a 100-mesh screen. Particle size is not as important in the case of the Mississippi liming materials which contain clay as an impurity which causes the particles to break down so that they react with the soil. They must be crushed finely enough, however, so that they can be spread uniformly.

Generally, the Delta and Deep Loess soil areas are abundantly supplied with magnesium and a calcic lime will be satisfactory. In the other soil areas of the state, magnesium levels tend to be lower and a liming material containing considerable magnesium, such as dolomitic lime, should be used, particularly in the Northeast Blacklands.

Fertilizer Efficiency

In crop production the primary objective of using fertilizers is to increase the net profit per acre. The rate of fertilizer required for maximum profit per acre depends upon many factors. Some of the more important ones are: (1) crop, (2) soil and fertilizer characteristics, (3) time and method of application of fertilizer, (4) degree of insect, disease, and weed control, (5) weather, (6) planting pattern and (7) increase in yield, together with the ratio of costs to returns from fertilizer. Under a given set of circumstances, the efficiency of utilization of fertilizer by a crop may be greatly affected by time and/or method of application.

Time of Application

In general fertilizer nutrients are reduced in effectiveness following their application to the soil because of loss by volitization and leaching and by conversion to less available or to unavailable forms.

Fertilizers may contain nitrogen in the form of nitrate or ammonimum, or both, or in other forms (urea and cynamide) that are changed rather rapidly to ammonium when applied to the soil. Nitrate salts found in fertilizers and in soils are highly soluble in water. Since they are not retained by combining with the soil, they are easily leached from the root zone, particularly on sandy loam, loam, and silt loam soils or other soils where water percolates easily through the soil profile. Under water-logged conditions nitrates in soils may be changed by soil organisms (denitrification) to gaseous nitrogen which escapes into the atmosphere. Ammonium nitrogen is not denitrified; neither is it easily lost by leaching because it combines chemically with the clay and organic matter. However, it is soon converted by soil bacteria to nitrate salts which may be lost as just indicated.

Thus, it is evident that nitrogenous fertilizers are not retained in soils of Mississippi for long periods, and accordingly, maximum efficiency for crop production is generally obtained by applying the nitrogen at or near the beginning or during the growing season.

Phosphate fertilizers are not lost from soils by leaching, but their availability to plants is reduced, particularly in acid soils, because they react rather rapidly with iron and aluminum to form phosphates that are much less available to plants. The reactions are referred to as "phosphate fixation." Because of this fixation, annual, seasonal applications of phosphate are better than less frequent or off-season applications. This is true for both annual and perennial crops. In general, best results are obtained by applying phosphate fertilizers at or just prior to seeding, or near the beginning of the growing period in the case of maintenance applications to perennial crops.

The effectiveness of potassic fertilizers is not reduced appreciably by fixation in Mississippi as is phosphate, nor is the potassium as easily leached from soils as nitrate. However, on sandy loam, loam, and silt loam soils the extent of loss by leaching is such that annual, seasonal applications are better than less frequent applications. Also, with harvested forage crops excessive uptake (luxury consumption) and removal of the potash in the harvested portion makes annual, and sometime split, seasonal applications necessary for optiumum efficiency even where the potash would not be lost by leaching. This is especially true where multiple harvests of forage crops like alfalfa, which are very heavy users of potash, are made.

Fall or winter plowing to prepare a seed bed is highly desirable, if not essential, for most successful row-crop production on heavy clay soils such as occur in the Blackland Area. Where equipment is not available for proper placement of fertilizer in a prepared seed bed in the spring, the phosphate, and potash, and magnesium where recommended should be applied at the time the seed bed is prepared. The method of application should be such that the location with respect to the seed row will be in conformity with the recommendations for the crop in question. Except for the black clay upland soils and the clay bottom soils of the Northeast Blackland Area or other Clay soils known to be either slightly acid or alkaline in reaction, the recommended rate of phosphate shoud be increased by about 50 percent when applied in the fall or winter.

From the foregoing observations it is evident that the soil, fertilizer and crop characteristics must be taken into account in order to time the application of fertilizer so that maximum availability to and need by the crop are made to coincide in so far as it is practical to do so. This is reflected in the recommendations given later.

Method of Application

In selecting a method for applying fertilizer, there are two components of availability that must be considered: namely, positional and chemical.

Chemical availability refers to the capacity of the fertilizer to supply nutrients to plants. The chemical availability of phosphatic fertilizer is affected somewhat by the method of application, particularly on acid soils. Banding water-soluble and other highly reactive phosphates as opposed to broadcasting and mixing them with the soil increases their chemical availability because of reduced contact with the soil which in turn slows up the process of phosphate fixation. When coupled with proper placement with respect to the seed row of drill-seeded and row crops, the effectiveness of the phosphate sometimes is doubled. The chemical availability of potassic and nitrogenous fertilizers is not so greatly affected by degree of contact with the soil, thus banding as opposed to broadcasting is of little advantage in this respect.

Positional availability refers to the location of the fertilizer with respect to the plant roots. For example, fertilizer placed in the soil a foot or so from the row is positionally unavailable to plant in the seedling stage.

Phosphatic and potassic fertilizers applied to the surface do not penetrate the soil to a very great depth. If applied in this way to row crops, they may remain positionally unavailable throughout the growing season because cultivation disturbs the soil, and plant roots do not persist in the surface inch or so where the fertilizers are held, particularly the phosphate. Also, nitrogenous fertilizers applied to the surface of the soil, particularly when dry, remain unavailable for the most part until dissolved and moved down into the root zone by percolating water. On most soils before ammonium sources of nitrogen are moved down into the root zone to any appreciable extent the ammonium must first be changed by soil bacteria to nitrate (nitrified), a process which usually requires 2 to 4 weeks for completion in moist soil during the spring and summer. If the nitrogen is applied far enough in advance for the necessary transformation and movement into the root zone to occur by the time it is needed by the crop, positional unavailability is avoided. Surface application of fertilizer is more effective with sod crops than with row crops except during periods of drought because plant roots develop and persist near the surface; in fact, this method is so effective that it is recommended for applying maintenance fertilizers to perennial, close-growing crops.

Even though nitrogenous fertilizers are mobile and may ultimately move downward into the root zone as nitrate with percolating water, not all solid sources of nitrogen and non-pressure solutions are equally effective for surface application. Solid urea and urea-ammonium nitrate solutions have not always been as effective as other sources of nitrogen such as ammonium nitrate for this purpose. When in contact with moist soil or decomposing plant residues, urea is changed to ammonium carbonate which is unstable and breaks down to yield gaseous ammonia. If this takes place at or near the surface of the soil some of the ammonia may escape into the atmosphere and be lost. This reaction proceeds more rapidly in warm seasons than in cold weather, therefore, losses of ammonia from surface-applied urea are apt to be higher during the spring and summer than in late fall and winter. Also, because of the high activity of urease where there is an accumulation of plant residues, losses are likely to be greater where urea is applied to grass sods than when applied to the surface of clean cultivated soils.

On the average solid urea has been just as effective as solid ammonium nitrate for surface application to small grains for forage and grain production and about 85 percent as effective as solid ammonium nitrate for surface application to summer-grass pastures.

Thus far the urea-ammonium nitrate solutions (30 to 32%), such as N-Sol-32 and Uran have not been as effective as either solid urea or ammonium nitrate for surface application to small grains forage and to summer-grass pastures. On summer-grass pastures they have been about 60 percent as effective as ammonium nitrate and on small grain for forage about 75 percent as effective.

On row crops, both solid urea and urea-ammonium nitrate solutions appear to be slightly inferior to ammonium nitrate for surface application. When placed in the soil there are no differences among these sources for crop production.

To be readily available to the seedling, the fertilizer must be placed relatively close to the seed, usually to the side of and below so that the fertilizer is contacted by the secondary roots soon after they have begun to develop. The fertilizer should be deep enough to be in moist soil most of the time during the growing season. On the other hand, to avoid salt injury to the germinating seeds and to the seedlings, care must be taken not to place the fertilizer too close to the seed, or in such a position that salts in excessive amounts may move in around the seed or seedling. Since the fertilizer salts in solution move upward or downward with soil water and to some extent laterally by diffusion, the fertilizer should be placed to the side of the seedrow, the distance depending on the kind and rate of application.

Nitrogen and potassium salts are largely responsible for salt injury due to improper placement of fertilizer. Unless they are drilled together in the same band, phosphatic fertilizers and the seed are not likely to come in contact with each other because the phosphate will not move far enough from the fertilizer band to contact the seed before reacting with the soil to become relatively insoluble in water and, thus, immobile.

With row crops and most drill-seeded crops both chemical and positional availability during the growing season are maximized and injurious concentrations of salts around the seeds or seedlings are avoided by placing the fertilizer in narrow bands at least two inches to the side of and two inches below the seed. The minimum separation may be employed with recommended rates of phosphate and potash and up to 40 pounds of nitrogen per acre. With higher rates of nitrogen and potash both the vertical and horizontal distances between the seed and fertilizer should be increased.

Although contact placement of seed and fertilizer should be avoided with most crops and is not the preferred practice in this case, recommended amounts of phosphate and a combined total of 50 pounds of potash plus nitrogen may be drilled with small grain or grass seeds without appreciable injury in most cases when drills are spaced no more than 10 inches apart. Higher rates of fertilizer, particularly of potash and nitrogen, should be placed two inches or so below and to the side of the seed.

Although maximum efficiency of phosphate and potash are generally obtained by band placement on row crops and drill-seeded crops, optimum yields can be obtained with broadcast application of these nutrients. However, because of reduced efficiency with broadcast application, especially where these fertiliers are applied to the surface and disked in rather than being plowed down, the rate of application should be 30 to 50 percent greater than is recommended for band application. Disking to incorporate fertilizers applied broadcast probably does not mix them into the soil deeper than two to three inches. As pointed out before, nitrogenous fertilizers will move downward in time but the phosphate and potash do not move downward to any great extent, therefore, they should be placed so as to be accessible to plant roots throughout the growing season.

Foliar Feeding: Plants absorb and utilize nutrients applied in solution to their leaves and if a deficiency exists, yields and/or quality may be improved by foliar application. Because they are required in such small amounts, very dilute nutrient salt solutions of the micronutrients (trace elements) may be used quite satisfactorily as foliar sprays to correct deficiencies without injury (burning) to foliage. In some areas foliar feeding of trace elements has become a somewhat standard practice for crop production. Oftentimes, micronutrients (trace elements) are applied conveniently and inexpensively along with insecticides and fungicides. A typical example is the application of boron to cotton with the insecticide. However, so far, under Mississippi conditions there appears to be no need for both foliar and soil application of micronutrients where they are needed for crop production.

The primary (nitrogen, phosphous, and potassium) and secondary (sulfur, calcium, and magnesium) nutrients, referred to collectively as macronutrients, are absorbed in relatively large quantities by crops. Thus, to supply a substantial part of the total requirement of these nutrients without burning the leaves of plants would require several applications of rather dilute solutions during the growing season. Therefore, foliar feeding of these nutrients is not as feasible as foliar feeding of the micronutrients. Increases in the yield of cotton have been obtained in Mississippi under certain conditions from foliar feeding of the primary nutrients, but it has not been shown so far that this is a desirable or economical alternative to soil application of these nutrients. Therefore, foliar feeding is not now recommended routinely in lieu of or as a supplement to soil application of the primary and secondary plant nutrients.

Recommendations for Major Field Crops

CORN

Area 1, Northeast Mississippi:

White Embro Departure VIII, Dixie 55, Dixie 77, Funk's G-795W-1.

Yellow: Dixie 22, Pioneer 309B, Funk's G-711AA, Funk's G-707, Embro Jarvis E, Embro 222TA, McCurdy M97.

Area 2, Delta and Foothills:

White: Funk's G-795W-1, Dixie 55, Dixie 77.

Yellow: Coker 67, McCurdy M97, Pioneer 309B, Funk's G-711AA, Funk's G-707, Embro 222TA, Funk's G-732, Dixie 18, Dixie 22, Dixie 82, DeKalb 1213.

Area 3, North Central Mississippi:

White: Funk's G-795W-1, Dixie 55.

Yellow: Funk's G-720, Funk's G-732, Funk's G-711AA, Funk's G-707, Pioneer 3048, Dixie 22, Dixie 82, Embro Jarvis L, DeKalb 1213.

Area 4, South Central Mississippi:

White: Coker 811A, Funk's G-795W-1, Dixie 55.

Yellow: Coker 71, Coker 67, DeKalb 1213, Dixie 82, Dixie 18, Dixie 22, Embro Jarvis L, Funk's G-732, Funk's G-745A.

Area 5, South Mississippi:

White: Funk's G-795W-1, Coker 811A, Dixie 55.

Yellow: Coker 67, Coker 71, Funk's G-732, Funk's G-745A, Funk's G-740, DeKalb 1212, Dixie 18, DeKalb 1213, Embro 260, Pioneer 3048.

Silage Corn: Any full season hybrid recommended for grain for the area in question.

Seeding Rates and Dates and Land Selection: Plant in South Mississippi from March 20 to April 10, in Central Mississippi from April 1 to April 15, and in North Mississippi from April 10 to April 15. Corn should be planted on reasonably deep soils with fair to good surface drainage. Steep, droughty, and eroded hillsides should be avoided. Plants should be spaced in the row to give plant populations ranging from 8,000 to 15,000 plants per acre depending upon the soil productivity, fertilization rate, expected moisture supply, and the yield expected.

These stands require row spacings of about 10 to 18.5 inches on 42-inch rows for 15,000 to 8,000 plants, respectively, and 10.5 to 19.5 inches on 40-inch rows.

Stands should not exceed 12,000 plants per acre except on highly productive bottomland soils or where irrigation is employed. On most upland soils stands generally should not exceed 10,000 plants per acre.

Fertilization, Hill and Delta Foothill Area: For the soils in this area nitrogen phosphate and potash are generally needed for corn. Occasionally, following the application of lime, zinc deficiency may be encountered on soils of coarse to medium texture. When this occurs a mixed fertilizer containing zinc should be applied. No other micronutrient deficiencies have been observed in corn.

Time: All of the phosphate and potash should be applied before or at planting time. Nitrogen may be applied at or before planting time or in split applications except that on sandy and sandy loam soils with very good to excessive internal drainage split applications should be made. Even though good results can be obtained by applying all the nitrogen at or before planting time on many soils, it is often a safer and more economical practice to apply two-thirds or more of the nitrogen as a side dressing. Side-dressed nitrogen should be applied by the time the corn is knee high.

Rate: For stands of 8 to 12 thousand plants per acre, apply 36 to 48 pounds each of phosphate (P_2O_5) and potash (K_2O) per acre and 48 to 60 pounds of each for stands between 12 and 15 thousand plants. Depending upon the stand, apply 100 to 200 pounds of nitrogen per acre. To adjust the nitrogen rate with stand apply about 1.3 pounds of nitrogen per acre for each 100 plants.

For silage the stand should be 12 to 15 thousand plants per acre. After corn has been grown successively for silage, for three years on the same field, apply 48 to 60 pounds of phosphate (P_2O_5) and 96 to 120 pounds of potash (K_2O) per acre.

Method: Band application of phosphate and potash beside the row is recommended. To obtain the greatest influence on early growth of corn the phosphate and potash should be placed 2 to 4 inches to the side of and 2 to 4 inches below the seed. As much as 60 pounds of nitrogen per acre can be applied with the phosphate and potash but the maximum separation of seed and fertilizer just indicated should be employed. If higher rates of nitrogen are included with the phosphate and potash both the horizontal and vertical separation of seed and fertilizer should be increased by 1 to 2 inches. Preplant applications of anhydrous ammonia should be placed 5 to 6 inches to the side of the seed row and 6 or more inches below the level of the seed.

Avoid contact placement of seed and fertilizer and shallow placement of fertilizer directly beneath the seed.

Side dress applications of nitrogen should be placed a foot or more from the row, non-pressure solutions and solid sources at a depth of 3 to 5 inches and anhydrous ammonia at a depth of 6 inches.

Fertilization, Delta Section: Time: Nitrogen may be applied at or prior to planting or in split applications, one-half at or before planting and the rest as a side-dressing before the corn is knee high.

Rate: 120 to 180 pounds of nitrogen per acre.

Method: Place preplant and planting time applications of nitrogen 4 to 6 inches from the drill row, non-pressure solutions and solid sources at a depth of 4 or more inches and anhydrous ammonia at a depth of 6 or more inches below the level of the seed. Place side-dress applications of nitrogen 1 foot or more from the row, non-pressure solutions and solid sources at a depth of 4 or more inches and anhydrous ammonia at a depth of 6 inches.

COTTON IN THE DELTA

Varieties: Auburn 56, Carolina Queen, Deltapine 45, Stoneville 213, Deltapine Smooth Leaf, and Stoneville 7A.

Seeding Dates and Rates: Plant as soon after April 1, as weather permits, but not in cold soil. Hill dropped 16 to 22 pounds of well delinted seed per acre. Drilled—30 to 40 pounds of well delinted seed per acre. Drilled for cross plowing—60 pounds of delinted seed per acre. Seed should be of good viability.

Fertilization: Delta soils generally need nitrogen fertilizer only for most profitable production, but in the foothills area, the use of phosphate and potash frequently may be profitable. Lime should be used to maintain the soil pH between 5.5 and 7.0.

Time: Apply nitrogen in the spring at or prior to planting, except on sandy loam soils having very good to excessive internal drainage and on clayey soils with poor surface drainage. On such soils, split application of nitrogen should be made, one-half at or prior to planting and the rest as a side dressing preferably by mid-June. Split application of nitrogen on clays with poor surface drainage is recommended because of possible loss of nitrogen by denitrification during wet periods.

Rate: Sandy loam, loam, and silt loam soils, 90 to 100 pounds of nitrogen per acre; clay loam, silty clay, and clays, 100 to 120 pounds of nitrogen per acre, except that for clays with poor surface drainage the rate should be 120 to 150 pounds of nitrogen per acre.

For cotton following soybeans or pasture sod, the nitrogen rate should not exceed 60 pounds per acre, especially following pasture sod.

Where stalk growth is too rank, maturity too late, or boll rot too great the nitrogen rate should be reduced to 75 pounds per acre.

All nitrogen fertilizer recommendations are on the basis of a planted acre regardless of the planting pattern, that is, whether skip-row or solid.

COTTON IN HILL SECTION

Varieties: Stoneville 213 and Carolina Queen have led in variety tests followed by Stoneville 7A, DeKalb 220, Empire WR 61, Stoneville 3202, Deltapine Smooth Leaf, Auburn 56, and Auburn M.

Fusarium wilt resistant; Auburn 56, Coker 100A, Auburn M. Carolina Queen, Empire WR 61, Dixie King II, Rex Smoothleaf and DeKalb 108.

Tolerant to Verticillium wilt: Auburn 56, Auburn M, Coker 100A, Stoneville 7A, and Rex Smoothleaf.

Auburn M, Rex Smoothleaf and Empire WR 61 cutout somewhat earlier than the others. Usually, Deltapine 45A has replaced Deltapine 45.

Seeding Dates and Rates: Plant between April 10 and May 10 as weather permits. Hill dropped—16 to 22 pounds of delinted seed per acre. Drilled—20 to 30 pounds of delinted seed per acre. For undelinted seed increase rates by 10 to 15 pounds per acre. Seed should be good quality.

Fertilization: A complete fertilizer containing sulfur and boron generally is needed for cotton in the Hill Sections. In addition, the fertilizer for cotton on black and brown or brownish black soils of the northeast Blackland Area should contain enough magnesium in water-soluble form to supply at least one-half and preferably as much magnesia as potash. On soil known to have a pH of 6.0 or below dolomitic lime may be used as a source of magnesium if it is broadcast and mixed with the soil at the rate of one to two tons per acre. An application of two tons per acre will supply enough magnesium for ten or more years.

Adequate boron is provided when the mixed fertilizer contains 0.3 lb of boron for each 48 pounds of phosphate (P_2O_5), or a phosphate to boron ration of 160:1. No more than 0.5 pounds of water-soluble boron per acre should be drilled with the fertilizer in close proximity to the seed

Under natural soil conditions cotton grows well within the pH range of 5.5 to 7.5 but acid soils should not be limed to raise the pH above 7.0. For liming recommendations see sections on Soil pH and Liming.

Time: Apply the phosphate and potash along with all or part of the nitrogen at or prior to planting. Side-dress applications of nitrogen should be made by mid-June — one to two weeks earlier if anhydrous ammonia is used — or at early square formation. On deep sandy or sandy loam soils having very good to excessive internal drainage one-half to two-thirds of the nitrogen should be applied as a side dressing for maximum efficiency.

For time of application of phosphate and potash to clay soils, especially in the Blackland Area, see section of Fertilizer Efficiency.

Rate: Apply 72 pounds of nitrogen (N), 48 pounds of phosphate (P_2O_5) and 48 pounds of potash (K_2O) per acre except as follows: Increase the rate of fertilizer to about 110 pounds of nitrogen and 60 pounds each of P_2O_5 and K_2O on the blackish and brownish, upland soils of the Northeast Blackland Area and to about 90 pounds of nitrogen per acre on the well-drained and bench-land soils of the Upper Coastal Plain and Northeast Blackland Areas.

Where a skip row planting pattern is followed the rate of nitrogen per planted acre should be the same as is recommended for a planted acre of solid cotton but the rate of P_2O_5 and K_2O should be increased to 60 pounds of each per planted acre where a lower rate is recommended for solid cotton. In a 4 x 4 skip row planting pattern there is of course only one-half acre of planted cotton. Fertilizer should not be applied to the skipped rows.

Too much nitrogen produces excessive vegetative growth, delays maturity, makes it more difficult to control insects, and increases the loss from boll rot. If these conditions prevail the nitrogen rate should be reduced by one-third if the recommended rate is being applied and at least to or slightly below the recommended rate if it is being exceeded. On the other hand, if the cotton is not producing sufficient vegetative growth and does not maintain a fairly dark green color in the leaves until near the end of the growing season the rate of nitrogen should be increased by 20 to 30 pounds per acre.

Method: Mixed fertilizers should be placed in narrow bands 2 to 4 inches to the side of and 2 to 4 inches below the cotton seed. If all of the nitrogen is applied with the phosphate and potash in a single band at or prior to planting the maximum separation recommended should be employed. Broadcast application of mixed fertilizer on bedded land followed by rebedding for planting is about as effective as band placement of the fertilizer. Contact placement of seed and fertilizer as well as very shallow placement even of relatively low rates of fertilizers containing nitrogen and potassium directly beneath the seed should be avoided. When applied at or prior to planting anhydrous ammonia should be placed 4 to 6 inches to the side of and deep enought to be 4 to 6 inches below the seed. Where weeds and grass are not a problem, broadcasting solid or non-pressure nitrogen solutions followed by shallow surface incorporations is as effective as other methods of application at planting except perhaps on clay soil. Place side-dress applications of nitrogen a foot or more from the row, non-pressure solutions and solids at a depth of 3 to 5 inches and anhydrous ammonia at a depth of 6 inches.

Side-dress applications of sources such as ammonium nitrate and nitrate of soda usually give about as good results when applied to the surface as when placed in the soil, but the effectiveness of urea and urea ammonium nitrate solutions is likely to be increased by in-soil placement. (See section on Fertilizer Efficiency).

RICE IN THE DELTA

Varieties: Long grain: Bluebonnet 50 maturing in 140-150 days, Dawn maturing in 125 — 135 days and Belle Patna and Bluebelle maturing in 105—115 days. Medium grain: Saturn, Nato and Nova maturing in 120 — 130 days.

Seeding Dates and Rates: Rice can be seeded from mid-April to mid-June depending upon variety. The very early varieties should not be planted until June. Seeding rate 90 to 110 pounds if drilled and 110 to 135 pounds if broadcast or water seeded.

Fertilization: Apply 80 to 100 pounds of nitrogen per acre on old crop land. New land will probably require no nitrogen for the first two years. Use phosphate and potash only if soil test shows need. Ammonium forms of nitrogen such as ammonium sulfate and urea are recommended. Fertilizer may be applied before seeding if covered by approximately 2 inches of soil. Otherwise, it may be applied just before the first flood or one-half before the first flood and one-half at 45, 55, and 65 days after emergence for the 105 — 115, 125 — 135 and 140 — 150 day varieties, respectively.

Soybeans

Varieties: Delta (listed in order of maturity) Hill, Hood, Lee, Semmes and Bragg.

Hill Section: Jackson, Bragg, Hampton Rebel, Bossier, Lee. Add Curtis, Hood, and Hill from Central Mississippi northward, and Hale 7 for the Flatwoods.

Soils: Soybeans are adapted to all Delta soils and to the more productive soils of the Hill Sections, such as good bottom and bench-land soils. Lower yields may be expected on eroded droughty upland soils.

Seeding Dates and Rates: May 1 to June 15 except extreme South Mississippi June 1 to June 20. Plant 40-50 pounds of good seed per acre.

Fertilization: Soybeans require no fertilizer on most Delta soils. Outside the Delta, fertilizer is usually necessary for satisfactory production and lime is needed on soils having a pH below 6.0.

Soybean growers should have the soil tested for lime, P_2O_5, and K_2O requirements, adding the recommended rates of each. If the soil test shows pH 6.5 or above and with medium or high amounts of available P_2O_5 and K_2O, applications of lime and fertilizers should be less effective in increasing yields. Fertilizer should be applied as a band 2 to 3 inches to the side and 2 to 3 inches below the seed. Avoid contact placement of seed and fertilizer as well as placement directly beneath the seed.

Inoculation: If not on land where a crop of well nodulated soybeans has grown within the last five years, the seed should be inoculated.

Molybdenum: Molybdenum is a trace element, one of the seven micro-nutrients recognized as essential to the growth and development of higher plants. It is required for the reduction of nitrates in the leaves of all plants and for nitrogen fixation in the root nodules of legumes. Molybdenum applied as a seed treatment (¼ oz./acre) to soybeans increased soybean yields significantly on unlimed acid soils and where low rate of lime were drilled or broadcast. The increase was greatest on unlimed acid soils and diminished as the lime rates increased.

SUGARCANE FOR SIRUP

Varieties. C. P. 36-111. On deep, well drained soils of light texture.

Seeding Dates and Rates: Cut seed cane at the top mature joint and at ground level, but do not strip before planting. Plant in the fall (October 15) at the rate of 2 stalks, that is, place stalks end to end with a whole stalk at the union. Plant the cane in 4-foot rows on land that has been broken 5 to 6 inches deep a few weeks earlier. To protect from cold and to provide good drainage, cover the cane 6 to 8 inches deep by forming a ridge over it so that the drainage furrows between the rows are 2 to 4 inches deeper than the cane.

Fertilization: In the spring apply 40 to 50 pounds each of nitrogen and phosphate (P_2O_5) and potash (K_2O) per acre shortly after germination of the eyes, or just before re-growth from the stubble. Place the fertilizer in a band so that it will be 4 to 6 inches to the side of the row and 3 to 5 inches deep after the ridges have been worked down, or 1 to 2 inches deeper than the cane. Side dress with about 30 pounds of nitrogen per acre before July. Place side-dressing nitrogen in the edge of the root zone deep enough to be in moist soil without being disturbed by subsequent cultivation.

Strip, top, and cut the cane before freezing weather. Harvesting as much as a month before processing improves sirup quality and reduces "sugaring".

Grasses, Legumes, and Small Grains

(See Tables on pages 18-23)

Supplementary Information on Pasture Recommendations for the Hill Section

If equipment is available drill or band placement of seed and fertilizer is recommended for the establishment of all pasture and forage crops. With small-seeded legumes and grasses care must be taken not to seed too deep.

For established pastures solid and liquid complete fertilizers and solid sources of nitrogen may be top-dressed. On summer grass pastures, however, the efficiency of top-dressed urea-ammonium nitrate (non-pressure) solutions has been quite low compared to solid ammonium nitrate.

Where conditions are especially favorable for legumes, the danger of bloat may prevent full utilization of legumes seeded alone or of grass-legume combinations such as Dallisgrass and white clover, particularly in the Deep Loess area. The drilling of small grains or ryegrass into such a pasture will lessen the bloat problem and supply additional forage. In North Mississippi orchardgrass may be seeded to help reduce bloat in clover pastures.

Because of the wide variety of soils to which these pasture recommendations will be applied, and of the extensive nature of the typical commercial livestock operation in Mississippi, particularly beef cattle, the pasture fertilizer recommendations are generally presented as a range instead of a single and more arbitrary figure.

The lower limit of the recommendation is estimated to be sufficient for plant establishment and (1) for reasonable yields of forage on soils well adapted to the particular pasture crop under consideration, (2) for periods of economic stress during which it is still necessay to maintain a reasonable supply of cheap forage, and (3) where acreage per animal unit is not a serious limiting factor.

The upper limit of the fertilizer recommendations continues to be the agronomic optimum and should be used where the (1) soil type, (2) management system, (3) type of livestock enterprise. and (4) economic trend are such as to justify the considerably higher yields of forage that result from its use.

For winter growing grass-legume combinations, the amount of nitrogen used and the time of application depend primarily upon when grazing is needed and upon the desired proportion of grass and legume. Although there is very little difference in the total season's production of forage, fall applications speed plant establishment, increase fall and winter yields, and tend to provide a more favorable grass-legume ratio. For milking cows, lambs and other classes of livestock or system of managements where fall and winter grazing is important, and where danger of bloat exists, the application of 30-60 lbs. N at planting time is recommended.

The yields of grass forages is greatly increased by the application of nitrogen and where weather conditions do not limit growth excellent response is obtained to high rates of nitrogen; therefore, the most economical rate will depend upon temperature, availability of moisture, and the use made of the additional forage.

To increase the utilization of the nitrogen or to obtain a more favorable distribution of pasture production, split applications of nitrogen are recommended for both summer and winter grass pastures, with 30 to 60 pounds being applied each time. Except for coastal bermudagrass where the last application may be as late as September 1, the last application of nitrogen to permanent summer pastures should be made no later than August 1, and two weeks earlier if anhydrous ammonia is used. Because of the increased frequency of drought, mid-summer applications of nitrogen are generally less effective than applications made in the spring and early summer. For this reason more nitrogen should be applied in the spring than in summer season.

It may be economical to apply up to 180 pounds of nitrogen per acre to millet and sudangrass; 200 pounds to common Bermudagrass, Dallisgrass, and Bahiagrass, and 250 pounds to Coastal Bermudagrass pasture.

For summer temporary grazing crops, best response is obtained from nitrogen applied 4 to 5 inches deep whether before planting or as a side dressing. Surface applications followed by dry weather may be of little value.

For winter growing grass or grass-legume pastures that are seeded late and from which no fall or winter grazing can be expected, the initial nitrogen application may be delayed until growing conditions are more favorable.

Fall application of phosphorus or potash is recommended if these nutrients are necessary to establish forage seedlings in the fall. However, spring application is more effective for spring and summer growth of perennial plants and those which come up in the spring. In general, fertilizers should be applied as close as practical to the time they are to be used by plants.

Recommendations For Pastures In Hill Sections

Pasture Crop	Recommended Varieties	Time of Planting	Rate of Seeding per Acre	Fertilization, lbs./A annual Application Except Lime
		GRASS-LEGUME COMBINATIONS		
Dallisgrass-annual lespedeza	Dallisgrass; domestic or imported. Annual Lespedeza; Kobe, Climax, Summit	Dallisgrass: Feb.-Apri.; Aug.-Oct. Lespedeza: Feb.-Mar.	10 lbs. Dallisgrass (live seed) 20 lbs. lespedeza	**Establishment:** 1 to 4 tons lime,* 60-100 lbs. P_2O_5, 30 to 60 lbs. K_2O.** **Maintenance:** 30 to 60 lbs. P_2O_5, 40-60 lbs. K_2O.
Dallisgrass-white clover	Dallisgrass: domestic or imported. White clover: La. S-1, Regal	Dallisgrass: Feb.-Apr.; Aug.-Oct. White clover: Sept. 1-Oct. 15	10 lbs. Dallisgrass (live seed) 2 lbs. white clover	Same as above
Annual Ryegrass clover	Ryegrass: Gulf, Magnolia. Clover: White, Regal, Crimson, Chief, Dixie Autauga, Frontier.	Sept. 1-Oct. 15	20-25 lbs. ryegrass; 3 lbs. all varieties white clover, or 20-25 lbs. Crimson clover	1 to 4 ton lime,* 0-20 lbs. N, 60 to 100 lbs. P_2O_5, 30 to 60 lbs. K_2O**
Small grain and clover	Small grain: oats, wheat, rye, barley. Clover: Frontier, reseeding crimson: orbit red clover	Sept. 1-Oct. 15	90 lbs. small grain; 20-25 lbs. all crimson clover; 10 lbs. red clover	Same as above
Tall Fescue & white clover	Tall fescue: Alta, Kentucky 31. White clover, La. S-1, or Regal	Sept. 1-Oct. 15	3 lbs. clover 10 lbs. fescue	1-4 tons lime,* 60-100 lbs. phosphate (P_2O_5, 30 to 60 lbs. potash (K_2O)**

LEGUMES*****

Annual lespedeza	Kobe, Climax, Summit	Feb.-March	25 lbs.	1 to 4 tons lime,* 40 to 60 lbs. P_2O_5, 30 to 60 lbs. K_2O**
Lespedeza-sericea	Serella	Feb.-July 1	30-35 lbs. (hulled)	Same as above
Austrian winter pea		Sept. 1-Oct. 15	50 lbs.	Same as above
Rough peas	Also known as Wild Winter Peas, Caley peas, Singletary pea	Sept. 1-Oct. 15	50 lbs.	Same as above
Kudzu		Between last frost & May 1	500-1000 crowns	Same as above
Vetch	Warrior	Sept. 1-Oct. 15	30 lbs.	Same as above
Crimson clover ****	Reseding: Autauga, Chief, Dixie. Non-reseeding: Frontier	Sept. 1-Oct. 15	20-30 lbs.	Same as above. For seed production add 5-10 lbs. borax
White Clover	La. S-1 or Regal	Sept. 1-Oct. 15	4 lbs.	Same as for Dallisgrass lespedeza except 5 to 10 lbs. of borax for seed
Red Clover	Orbit	Sept. 1-Oct. 15	8-10 lbs.	**Establishment:** 1 to 4 tons lime,* 60 to 100 lbs. K_2O. For seed 5 to 10 lbs. borax. **Maintenance:** 40 to 60 lbs. P_2O_5, 40-60 lbs. K_2O. For seed 5 to 10 lbs. borax**
Alfalfa	Delta, Cody, Atlantic, Williamsburg, Kansas, Common & Cherokee	Sept. 1-Oct. 15	20 lbs. per acre	**Establishment:** 1 to 4 tons lime,* 150-200 lbs. P_2O_5. 150 to 200 lbs. K_2O. 10 lbs. borax. **Maintenance:** 60-100 lbs. P_2O_5, 180-240 lbs. K_2O, 10 lbs. borax**

The following crops are recommended for Hay: Coastal bermudagrass, Johnsongrass and sorghum-sudan hybrids and alfalfa, sericea, red clover, annual lespedeza and alyce clover. When used for hay increase the pasture fertilization rate for K_2O by 100% all species and double the nitrogen on grasses used alone for hay. i.e., Coastal bermuda for pasture, 60-180 lbs. N., for hay use 120-400 lbs. N/A.

Recommendations For Pastures In Hill Sections—(Continued)

Pasture Crop	Recommended Varieties	Time of Planting	Rate of Seeding per Acre	Fertilization, lbs./A annual Application Except Lime
		WARM SEASON GRASSES		
Dallisgrass	Domestic, imported	Feb.-April; Aug.-Oct.	10 lbs. (live seed)	Lime,* 60 to 120 lbs. N in split applications, 30 to 60 lbs. P_2O_5, 30 to 60 lbs. K_2O**
Bahiagrass	Pensacola, Argentine	Feb.-April; or Aug.-Oct.	15 lbs./A	Same as for Dallisgrass except P_2O_5 and K_2O applications 4 to 5 year intervals only.
Bermudagrass	Common Coastal	Feb.-May Feb.-May	5 lbs. seed 20 bu. of sprigs per acre	Same as for Dallisgrass Lime,* 60 to 180 lbs. N., 50 to 70 lbs. K_2O**
Millet	Cattail, Starr, SX121, Gahi	Seeded by June 15	10 lbs. in rows 25 lbs. broadcast	N-120 lbs. split, 60 P_2O_5,, 60 K_2O
Sudan	Greenleaf	Seeded by June 15	10 lbs. in rows 25 lbs. broadcast	N-120 lbs. split, 60 P_2O_5, 60 K_2O
Sorghum-sudan hybrids	Lindsey 77F, Grazer, MorSu, SX-12, Haygrazer, and Pioneer 980, Kow Kandy	Seeded by June 15	10 lbs. in rows 25 lbs. broadcast	N-120-180 lbs. split as above.
Johnsongrass	Commercial	Feb.-May	25 lbs. drilled or broadcast	N-200-400 lbs. split in 2 or 3 applications, P_2O_5-60, K_2O-120 lbs.
Grain Sorghum Silage (combine height)	RS 610, AKS 614, GA 615, Savannah, RS 617, E 56 a, P.A.G. 515S, NK 227, TE 66, Lindsey 555, Ranger B, Kiowa, DeKalb E57 and F64	Apr. 25-July 15 (Early dates preferred) If first havest is made by July 25, a second cutting can usually be made if soil moisture is adequate	6-9 seeds per ft. of 38-40" row 6-9 lbs. per acre)	80-120 lbs. nitrogen, 50 lbs. phosphate, 100 lbs. potash at planting time. If second crop is desired, side dress stubble with 40-60 lbs. nitrogen after first cutting.
(Intermediate Height)	FS1A, NK 300, 101-F	Apr. 25-July 1 (Early dates preferred)	4-6 seeds per foot of 38-40" row. (4-6 lbs. per acre).	100-150 lbs. nitrogen, 40-50 lbs. phosphate, 80-100 lbs. potash at planting time.

COOL SEASON GRASSES

Tall Fescue	Alta and Kentucky	Sept. 1-Oct. 15	10-15 lbs.	Lime* 60-150 lbs. of Nitrogen in split applications in fall & spring; 30-60 lbs. of P_2O_5; 30-60 lbs. of K_2O
Rescuegrass	Lamont	Sept. 1-Oct. 15	30-40 lbs.	Same as for Tall Fescue
Annual Ryegrass	Gulf, Magnolia	Sept. 1-Oct. 15	20-30 lbs.	Lime* 90-200 lbs. of Nitrogen in split applications, 30-90 lbs. P_2O_5; 30-60 lbs. K_2O
Oats	Sumter, Midsouth, Moregrain, Delair. Most oats have winter killed in variety tests in two years out of the last four, in northern half of Miss.	For Forage: Sept. 1-Oct. 1 For Grain: Oct. 1-Nov. 15	For Forage: 128 lbs. (4 bu.) For Grain: 2½ bu.	**For Forage:** Same as for Ryegrass. **For Grain:** 10 lbs. nitrogen, 20 lbs. phosphate and 20 lbs. potash at seeding. Topdress with 40 to 60 lbs. nitrogen about March 1**
Rye (Grain)	Elbon, Explorer, and Abruzzi, NC. A sudden cold snap following a warm spell will injure rye, particularly as late as March 15.	Same as Oats	For Forage: 90 lbs. For Grain: 1½ bu.	**For Forage:** Lime* Same as for Ryegrass. **For Grain:** Lime* Same as for Oats
Wheat (Grain)	Knox, Ace, Coastal, Georgia 1123, Monon, Vermillion, Bledsoe, Wakeland. Varieties which grow off fastest are most likely to suffer from cold. Of the above, Ace, Monon, and Vermillion are most likely to escape serious cold injury.	Same as for Oats	For Forage: 90 lbs. For Grain: 1¼ bu.	**For Forage:** Lime* Same as for Ryegrass. **For Grain:** Lime* Same as for Oats
Barley (Grain)	Dayton, Harrison, Kenbar, and Decatur. Barley will be damaged by severe cold as indicated for wheat.	Same as for Oats	For Forage: 90 lbs. For Grain: 1½ bu.	**For Forage:** Lime* Same as for Ryegrass. **For Grain:** Lime* Same as for Oats
Grain Sorghum (for grain)	Brown grain, open heads: AKS 614, GA 615, Savannah, RS 617	Apr. 25-July 1 (Early dates preferred)	6-9 seeds per foot of 38-40" row. (6-9 lbs. per acre.)	80-120 lbs. nitrogen; 30-40 lbs. phosphate; 30-40 lbs. potash at planting time

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*See section on soil pH and liming for recommendations as to rate of lime to apply to different soils and crops in the absence of a soil test or other knowledge of the lime statute of the soil.

**Or the approximate quantity of any mixed fertilizer which contains the ratio of nitrogen (N), phosphate (P_2O_5) and potash (K_2O). ****On land adapted to that particular crop.

*****All legume seeds should be inoculated with the proper strain of bacteria just prior to planting.

Recommendations For Delta Pasture And Grain Crops

Pasture Crop	Recommended Varieties	Rate of Seeding per Acre	Fertilizer	Time of Planting
Alfalfa	Buffalo, Kansas Common Oklahoma Common	10-20 lbs.	Test soil for lime, phosphorus and potash. Apply minerals prior to planting and work into seedbed	Oct. 1-15
Bermuda Grass	Common Coastal (Irrigated)	5 lbs. Sprig	60 lbs. nitrogen June 1 180 lbs. nitrogen (4 applications 45 lbs. each, June 1 and each 30 days)	Mar. 1-May 1 Nov. 1-May 1
Dallisgrass	Imported or Domestic	10 lbs. Live Seed	30 lbs. nitrogen June 1	Mar. 1-May 1
Fescue and Ladino	Kentucky 31	5-10 lbs. Fescue 1-2 lbs. Ladino	30 lbs. nitrogen at planting 60 lbs. nitrogen September 1 for winter grazing	Oct. 1-Nov. 1 Feb. 1-May 1
Red Clover	Orbit, Port Gibson, Kenland	10-15 lbs. seed alone or in small grains	Test soil for lime, phosphorus and potash	Oct. 1-Nov. 1
Ladino Clover		1-2 lbs. seed with grass	Test soil	Oct. 1-Nov. 1
White Clover		2-4 lbs. seed with grass	Test soil	Oct. 1-Nov. 1
Crimson Clover	Hard seeded for volunteer crop	12-15 lbs.	Test soil for lime, phosphorus, and potash	Oct. 1-Nov. 1
Sudan grass	Tift, Greenleaf	6-10 lbs. in 40" rows	60 lbs. nitrogen prior to planting	June 1-20
Lespedeza	Korean or Climax	20-25 lbs. seed in small grains		Feb. 15-Mar. 15
Grain sorghum	DeKalb E56a & D50a, RS 610	6 to 8 lbs. 38" to 40" rows	90 to 120 lbs. nitrogen prior to planting	April 20-July 10
Oats	Delta Red 88 Coker 242 Ora, Moregrain, Delair, Midsouth	3 bu. for grazing 2½ bu. for grain	60 lbs. nitrogen in Sept. for winter grazing 45 to 60 lbs. nitrogen Feb. 20-Mar. 15 for grain	For grazing early September For grain, mid-October
Wheat	Ga. 1123, Knox, Bledsoe, Hadden, Atlas 66	1¼ bu. for grain 1½ bu. for grazing	Same as for oats	Same as oats
Rye	Explorer, Elbon	1¼ bu. for grain 1½ bu. for grazing	Same as for oats	Same as oats

Barley	Rogers, Dayton, Kenbar	75 lbs. for grain 90 lbs. for grazing	Same as for oats	Same as oats Plant only on well drained sandy soil
Ryegrass	Annual	25-30 lbs.	60 lbs. nitrogen prior to planting 60 lbs. nitrogen in March	Sept. 1-30
Johnsongrass and red clover mixture		10-15 lbs. spring 10 lbs. fall	60 lbs. nitrogen June 15	April 1-June 1 Oct. 1-Nov. 1 after Johnson grass established

Recommendations For Lawns And Similar Turf Areas

Grass	Recommended Varieties	Method of Planting	Rate of Planting	Fertilization per 1000 Sq. Ft. per Yr.
Bermudagrass	Common Tiflawn, Ormond, Tifway, Tifgreen, Tex-turf 10	Seed Sprig or plug	2 lbs./1000 sq. ft. Sprig or plug 6-12 ins. apart on 6-12 in. rows	6-8 lbs. nitrogen 3 lbs. P_2O_5 4-6 lbs. K_2O, split into 4 applications
Zoysiagrass	Emerald, Matrella, Meyer	Sprig or plug	Sprig or plug 6 ins. apart on 6 in. rows	5-6 lbs. nitrogen 2-3 lbs. P_2O_5 3-4 lbs. K_2O, split into 4 applications
St. Augustine	Common	Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows	Same as zoysia
Centipede	Common, Oklawn	Seed Sprig or plug	4 oz./1000 sq. ft. Sprig or plug 6-12 ins. apart on 6-12 in. rows	2-3 lbs. nitrogen 1-2 lbs. P_2O_5 1-2 lbs. K_2O, split into 2-3 applications
Carpet	Common	Seed	5 lb./1000 sq. ft.	Same as centipede
Bahia	Argentine, Pensacola Paraguayan, Wilmington	Seed	5 lb./1000 sq. ft.	Same as zoysia
Annual Ryegrass	Gulf, Magnolia	Overseed	8-10 lb./1000 sq. ft.	1 lb. nitrogen in January if needed

Supplementary Information for Lawns and Other Turf Areas

Use the best adapted grass. Bermudagrasses do not survive in the shade, but Zoysia, St. Augustine and Centipede do. In areas where the chinch bug makes the growing of St. Augustine difficult, change to another adapted grass. Tiflawn Bermudagrass, due to its fast recovery from use, is excellent on athletic fields and other play areas. Tifgreen Bermudagrass is recommended only for areas that will receive the best of management, such as golf greens and well-cared-for-lawns.

New turf areas should have nitrogen, phosphorus and potash worked into the top six inches of the soil prior to planting seed or vegetative material. Established turf areas should be fertilized regularly using a broadcast method of application. For best results begin fertilization of established turf areas in the early spring and continue until late summer. Caution should be exercised when applying fertilizers containing inorganic nitrogen materials to prevent damage to the grass. In any event, fertilized areas should be watered immediately after fertilization to wash fertilizer off the grass leaves and into the soil to prevent foliar burn.

Proper mowing techniques, watering, weed, insect and disease control are also important in a turf management program.

To keep turf in a vigorous state of growth, management in all its aspects is important.

Horticultural Crops

FERTILIZER RECOMMENDATIONS FOR ORNAMENTALS

Soil tests are recommended. If they are not available, then use the following recommendations.

Plant	Number of Applications	Time of Application	Fertilizer	Rate*	Remarks
Shade Trees					Fertilize at least every 3 years. Distribute in holes 12 in. deep, spaced evenly within branch spread, and use 20 holes/inch of tree diameter.
Trunk Diameter under 6 in	1	Oct. to March	12-8-8	1 lb./in. trunk diameter	
Trunk Diameter over 6 in.	1	Oct. to March	12-8-8	2 lbs./in. trunk diameter	
Shrubs and Flowers	1	Spring	6-8-8	2-4 lbs./100 sq. ft.	Use 1-2 lbs. per plant for specimen shrubs.
Commercial Crops or for special plants		Write for details on specific crops			

*Equivalent amounts of N-P-K may be applied by other materials.

FRUIT

Apples: Early Harvest, Lodi, Williams Early Red, Cauley, Golden Delicious, Red Delicious, Stayman Winesap.

Strawberries: South Mississippi—Headliner, Klonmore. Elsewhere — Pocohontas, Albritton, Dixieland.

Pears: Ayers, Orient, Baldwin, Morgan. Waite, Kieffer.

Plums: Bruce, Methley, Munson, America, Santa Rosa.

Peaches: Central and North Mississippi—Dixired, Dixigem, Redhaven, Triogem Halehaven, Loring, Sullivans Early Elberta, Georgia Belle, Elberta, Afterglow.

South Mississippi—June Gold, Hiland Maygold, Keystone, Sunhigh, Southland. Redskin, Afterglow.

Pecans: Stuart, Desirable, Farley, Lewis. Elliot.

Only in South Missisippi — Curtis.

Blackberries: Williams (semi-erect), Brazos (semi-erect), Thornless Boysen (trailing).

Raspberries: Sodus (purple), Sunrise (red), Morrison (black), Golden Queen (yellow).

Muscadines: Black — Magoon*, Burgaw*, Hunt, Dulcet, Thomas.

Bronze — Dearing*, Wallace*, Topsail, Scuppernong, Higgins.

*At least one of these pollinator vines must be included with all plantings.

Bunch Grapes: Concord or Champanel (blue), Delaware or Salamander (red), Niagara or Portland (white).

FERTILIZERS FOR FRUIT CROPS

Recommendations are for annual applications on soils of average fertility where clean cultivation is practiced in the summer. Soil samples or leaf analyses in commercial orchards may indicate need for different ratios. Commonly in the Deta area, only nitrogen fertilizer is needed.

Tree Fruits	Grade	Pounds per tree per year of afe
Applied under tree branches before growth begins in spring.		
Apples, Pears	12-16-16	½
If trees blight seriously, nitrogen fertilizer can be reduced or omitted. Maximum rates should be reached at 15-20 years.		
Peaches, Plums	12-16-16	½
	33-0-0	¼
Apply two-thirds of N fertilizer before growth begins and one-third in June or July. Maximum rates should be reached at 6 to 10 years.		
Pecans	12-16-16	1 - 1½
Strawberries (Central and North Mississippi)		
February	12-16-16	150-250
June	12-16-16	150-250
September	12-16-16	150-250
In South Mississippi apply 12-16-16 at rate of 3-5 pounds per 100 feet of row before setting plants and 1 to 3 pounds per 100 feet of row in January.		
Blackberries, Dewberries, Raspberries		
February	12-16-16	150-250
June	12-16-16	150-250
	33-0-0	100
Grapes (mature vines)	12-16-16	1-2 lbs. per vine

VEGETABLE VARIETY AND FERTILIZER RECOMMENDATIONS

The variety and fertilizer information supplied here is based on tests throughout Mississippi. The varieties listed are suitable for both home garden and commercial purposes unless otherwise designated. Vegetables as a group require more fertilizer per acre than most other row crops. The Mississippi Soil Testing Service is recommended for problem soils, or for specific recommendations for individual farms. This is especially true where the soil reaction (pH) is not known since many vegetable crop failures are due to improper liming.

			Fertilizers pounds per acre		
CROP	VARIETY	pH	N	P_2O_5	K_2O
Asparagus	Mary Washington	6.0-7.0	50	100	100
			After cutting season		
			After cutting season topdress with		
			25	50	50
Beans and Peas		5.8-7.0	50	100	50
Bush Lima			Sidedress in full bud stage with		
Small seeded	Clark's Bush, Henderson, Thaxter **Nemagreen****		32	0	0
Large seeded	Fordhook 242				
Colored seeded	Jackson Wonder				
Pole type lima	Carolina Sieva, Willow Leaf, Florida Speckle				
Bush snap	Highlander, Contender (oval) Harvester, Extender Provider (round)				
Pole snap	Kentucky Wonder, Blue Lake				
English Pea	Thomas Laxton, Wando, Little Marvel				
Southern Pea	Mississippi Crowder (brown), Mississippi Silver,** Bunch Purple Hull, Dixilee	5.8-7.0	20	40	40
Broccoli	Coastal, Primo, Spartan	5.5-6.5	20	40	40
			20-40 lbs. borax		
			When heads begin to form sidedress with		
			32	0	0
Cabbage	Round Dutch, Early Jersey **Wakefield***				
Cauliflower	Snowball-E or Snowball-M				
Collard	Vates, Morris Heading				
Mustard	Florida Broadleaf, Giant Southen Curled	5.5-6.5	48	48	48
			Sidedress with		
			32	0	0
Radish	Cherry Belle, Scarlet Globe, White Icicle (long)				
Turnip	Purple Top White Globe, Just Right, Shogoin (greens)				

Beet	Detroit Dark Red	6.0-7.0	75	100	100
			Sidedress with		
Carrot	Gold Spike, Touchon, Imperator		32	0	0
Spinach					
Savoy	Bloomsdale Long Standing, Old Dominion,				
Smooth	Viroflay, Hybrid No. 7 or 10				
Cantaloupe	Rio Gold, Edisto, Hales Best No. 36, Homegarden*	5.5-6.5	40	80	80
			When plants begin to run		
			Sidedress with		
			30	30	30
Cucumber					
Slicing	Ashley, Long Green,				
Pickling	Model				
Squash	Early Summer Crookneck, Early Prolific Straightneck, White Bush Scallop				
Watermelon	Blackstone, Verona, Charleston Gray, Garrisonian				
Eggplant	Florida Market, Black Beauty	5.5-6.0	75	100	100
			Sidedress with		
			32	0	0
Irish Potato	Red LaSoda, Superior, LaChipper				
Pepper, Bell	Early Calwonder, Keystone Resistant Giant				
Pepper, Hot	Long Red Cayenne	5.5-6.0	40	80	80
			Sidedress with		
Pepper, Pimiento	Trueheart Perfection Mississippi Nemaheart**		30	30	30
Tomato		6.0-7.0	60	120	60
Red	Marion, Floradel,		Sidedress with		
			40	40	40
Pink	Pink Shipper, Bradley				
Greenhouse Production	Tuckcross O, V or K** Manapal, Step 352		Based on soil testing		
Lettuce,		6.0-7.0	75	100	100
Leaf	Grand Rapids, Bibb		Sidedress with		
			32	0	0
Head	Great Lakes (A-36 or 118)				
Greenhouse	Grand Rapids, Bibb				
Okra	Emerald, Clemson Spineless, Louisiana Green Velvet	6.0-6.5	30	40	40
			Sidedress with		
			20	0	0
Onion	Grano, Granex, Multiplier	6.0-7.0	50	100	100
			Sidedress with		
			50	0	0
Sweet Corn	Royal Gold, Golden Security, Illinichief Super Sweet, Seneca Brave	5.5-6.5	30	40	40
			Sidedress with		
			64	0	0
Sweet Potato	Centennial, Goldrush, Unit I Porto Rico	5.5-6.5	40	80	80

*Home Garden only. **For areas where nematodes are a problem

TUNG

Varieties: Isabel (L-2), Folsom (L-47), Gahl (L-51), La Crosse (F-99), and Lampton (F-587).

Fertilization: Apply fertilizer to nonbearing orchards as shown in Table 1. Fertilize newly planted trees soon after growth starts, spreading the mixture evenly in bands about 6 inches wide, the inner edges of the bands about 12 inches from the tree trunks. In the second and subsequent years after planting, spread fertilizer evenly under the spread of the branches shortly before growth starts.

Fertilize bearing trees shortly before they blossom, adjusting rates to the potentional yield as shown in Table 2. When annual leaf analyses indicate that the elements are critical or out of the optimum range, then specific recommendations can be made by personnel of the Experiment Station, or the U.S.D.A. Tung Laboratory.

Usually it is more economical to apply the nitrogen as anhydrous ammonia, aqua ammonia, or ammonium nitrate and the phosphorus and potassium as 0-10-30 or superphosphate and muriate of potash than to apply a complete mixed fertilizer. If inadequate zinc is indicated by leaf analysis or symptoms, apply 2 ounces of commercial zinc sulphate per tree under 5 years of age. For older trees, apply 4 ounces. If magnesium or calcium is deficient, apply dolomitic lime to bring the pH up to 5.5 or 6.0. After the trees are large enough for the branches to nearly meet in the tree row, the fertilizer may be applied in bands on each side of the tree row. All solid fertilizers should be incorporated in the soil by cultivation.

Table 1. Fertilizer requirements of nonbearing tung orchards.

			Amount pounds/tree	
Years in the orchard	Fertilizer ratio	N	P_2O_5	K_2O
Newly planted	1-2-1	.05	.10	.05
One year	1-2-1	10	.20	.10
Two years	1-2-1	20	.40	.20
			pounds/acre	
Three years	2-1-2	50	25	50
Four years	2-1-2	60	30	60

Table 2. Fertilizer requirements of bearing tung orchards.

Potential production tons/acre	N	P_2O_5 pounds/acre	K_2O
0 to 1	75	25	75
1 to 2	100	50	100
2 or more	130	60	160

BULLETIN 723 MARCH 1966

Preemergence
Herbicide Injection For Weed Control

Mississippi State University

AGRICULTURAL EXPERIMENT STATION

HENRY LEVECK, Director

STATE COLLEGE MISSISSIPPI

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On Cover:

Figure 2. Weed control in an 18-inch band centered on the soybean drill following injection of vernolate at 2 lb/A.

PREEMERGENCE HERBICIDE INJECTION FOR WEED CONTROL

By C. G. McWHORTER, O. B. WOOTEN, and R. S. BAKER[1]

New herbicides for preemergence weed control in cotton and soybeans are rapidly becoming available to the farmer. Since 1961 the number recommended for use in both soybeans and cotton by the Mississippi Weed Committee increased from 5 to 10. This trend will increase as industrial organizations intensify their search for more selective herbicides.

Federal and State research not only develops new herbicides, but also aims to prove the efficiency of existing materials. For several years, research has been conducted with EPTC (ethyl **N,N**-dipropylthiolcarbamate) and vernolate (**S**-propyl dipropylthiocarbamate). This report discusses the new injection technique for applying EPTC and vernolate, and presents data for the calibration of injection equipment.

EPTC and vernolate, although excellent herbicides, present two closely related problems. The best method of application for good weed control, one problem, closely affects the other problem of avoiding crop injury. Both problems are largely eliminated by application with the Stoneville injector.

EPTC and vernolate are highly volatile, and if not incorporated or injected into the soil will quickly evaporate from a hot soil surface. Even after thorough mixing with a ground-driven soil incorporator, a small amount of herbicide will be lost by evaporation, thereby decreasing weed control.

By injecting thin streams of these herbcides into the soil about 3 inches apart, the volatility is utilized to control weeds between the points of injection. Herbicide losses due to volatilization apparently are reduced by use of the Stoneville injectors.

A single Stoneville injector consists of a thin metal blade sharpened on the leading edge. A small tube attached to the trailing edge of the blade conveys the herbicide to the bottom of the slit created by the blade. An operating depth of 1 to 1 1/2 inches results in good weed control. When the injectors are properly operating, no liquid is visible on the soil surface after they have passed through the soil. Figure 1 illustrates a single injector at operating depth in the soil, and injector spacing for use in cotton and soybeans.

Injector equipment can be adjusted to apply herbicides in both cotton and soybeans. The only differences in the equipment used in the two crops are in the spacing of the inside or center injectors, and the number of injectors per row. For vernolate in soybeans six injections per row spaced 3 inches apart are centered over the drill. For EPTC application in cotton four injectors per row are used. EPTC is more toxic to cotton than vernolate is to soybeans; therefore, the center injectors are set 8 inches apart. It is important that the injectors be precisely mounted in relation to the planter. The inside injectors should be no closer than

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[1] Plant Physiologist, Crops Research Division, Agricultural Engineer, Agricultural Engineering Research Division, U. S. Department of Agriculture, Plant Physiologist, Delta Branch Experiment Station, Stoneville, Mississippi, respectively.

Cooperative investigations of the Crops Research Division, Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the Mississippi Agricultural Experiment Station, Stoneville, Mississippi.

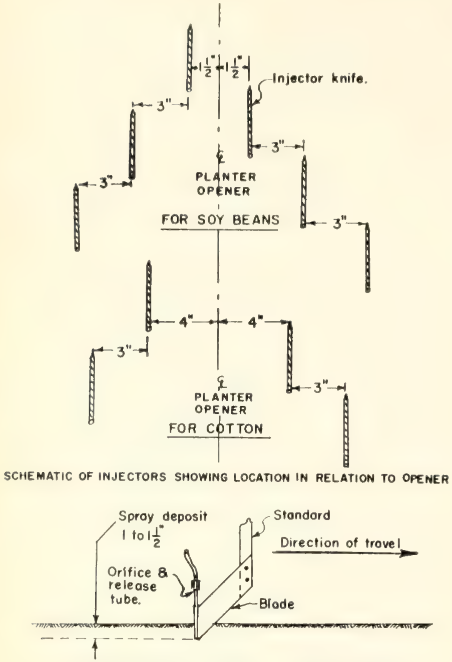

Figure 1. Injector setting for preemergence weed control in cotton and soybeans.

1 1/2 inches from the soybean drill or 4 inches from the cotton drill.

The injectors may not operate satisfactorily in fields where large weeds have been disked just before planting. Large amounts of loose trash may "ball up" ahead of the injectors and disturb the seedbed.

Vernolate Applied Preemergence in Soybeans

Vernolate, applied preemergence in soybeans at 2 to 3 pounds per acre, is effective on all soils. The highest rate is necessary only on heavy clay.

Vernolate will provide good to excellent control of grasses and broadleaved weeds such as crabgrass, goosegrass, cocklebur, morning glory, nutsedge, and pigweed. It will also control Johnsongrass from seed or from rhizomes or root stocks. Fig. 2 (on cover) shows typical control of weeds in soybeans obtained with venolate in 1965.

Injected vernolate has caused minor soybean injury. Under adverse conditions such as extremely heavy rainfall, slight injury has shown up immediately after emergence, but this was temporary and has not reduced soybean yields.

EPTC Applied Preemergence in Cotton

EPTC applied preemergence in cotton 1 1/2 lb/A is effective and safe for weed control in cotton. The heavier rate is necessary only on clay loam and clay. It controls a wide spectrum of small-seeded annual grasses and broad-leaved weeds in addition to nutsedge.

Use of EPTC as discussed in this report is a portion of the triband weed control program described in the 1966 Weed Control Recommendations issued by the Mississippi Weed Committee. With the inside injectors spaced 8 inches apart and centered on the drill, a 3- to 5-inch strip of weeds will escape the action of EPTC (Figure 3). Annual weeds in the immediate cotton drill can be controlled by application of a preemergence material such as diuron 3-(3,4-dichlorophenyl)-1,-1-dimethylurea or trifluralin **(alpha, alpha,alpha**-trifluoro-2,6-dinitro- **N, N**-dipropyl-**p**-toluidine).

One distinct advantage of EPTC over other preemergence materials is its consistent control of nutsedge as shown in Figure 3. While this weed is controlled only on the row shoulders, nutsedge that emerges in the immediate drill can be controlled with postemergence applications of herbicidal naphtha or DSMA (disodium methanearsonate) as recommended by the Mississippi Weed Committee. Two to three applications of these herbicides usually provide control until the cotton is large enough to shade the entire drill.

Injector Calibration

Injector equipment differs from more conventional herbicide spray equipment in that flat-disc orifices (rather than

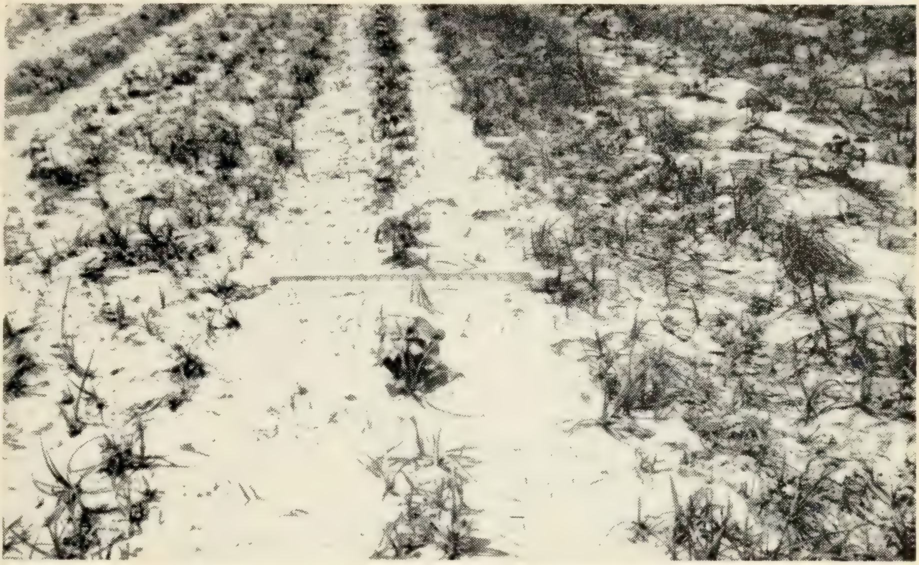

Figure 3. Nutsedge control in cotton with EPTC injected in two 6-inch bands starting 4 inches from the drill on both sides of the center row. To complete control use postemergence naphtha or DSMA.

conventional nozzle tips) are used to meter the spray solution. Also, four to six orifices per row are required rather than the conventional one tip.

As with other calibration procedures, the speed at which the planter-tractor travels in the normal planting operation is first determined (Table 1, Section C). Next, the correct orifice size and approximate pressure for the desired planting speed are selected fom the orifice size-guide in Table 1, Section B. The orifices are then placed in the nozzle bodies which are screwed to the delivery pipes on the rear of each injector. A regular 100-mesh nozzle screen is placed on top of the orifice in each nozzle body, the nozzle caps are tightened, and the equipment is ready for calibration.

Flat pans under the injectors can catch a full row at one time (Figure 4). The time in seconds to catch a quart of water at the desired operating speed is presented in the columns labeled 4 or 6 injectors in Table 1, Section C. The correct pressure is determined by varying the approximate pressure up or down until a quart is delivered in the specified time.

Example: If the equipment travels over a 300-foot course in 51 seconds for a speed of 4.0 MPH. The operator wishes to apply vernolate in soybeans, using 6 injectors per row. To determine the delivery time for 6 injectors, look down the right-hand column across from 4.0 MPH and find 62 seconds per quart. This indicates that 6 injectors should deliver 1 quart in 62 seconds to give a 20 gpa spray volume.

Band widths and spray volume rates for both four- and six-injector arrangements are given in Table 1, Section A. In both cases, the broadcast spray volume is 20 gal/A. Therefore, the herbicide tank mix is prepared to contain the appropriate amount of herbicide for 1 acre in 20 gallons of water.

Injection equipment and disc orifices for metering herbicide spray solutions described in this report will be available throughout the Delta of Mississippi in 1966. EPTC and vernolate will also be available throughout the Delta. The approximate cost of using EPTC on cotton will be from $0.85 to $1.25 per acre, depending on the rate. It will cost approximately $2.50 to $4.50 per acre for a preemergence treatment of venolate, depending on the width of the band and soil type. These are actual chemical costs, however, and they are in addition to application costs. Both materials control certain weed species that are extremely difficult to control with other herbicides. Because of this advantage it seems likely that these herbicides will be used in rapidly increasing quantities by Delta farmers.

Table 1. Calibration data for Stoneville injectors spaced at 3-inch intervals.

A. Desired rate of spray mixture expressed several ways and area covered by treatment.

	No. of injectors per row	
Rate expression or area covered	4	6
Gal/A, broadcast basis	20 gal	20 gal
Gallons delivered by all injectors on one row while traveling 13068 feet[1]	6 gal	9 gal
Total band width effectively covered by injectors	12 inch[2]	18 inch

B. Guide for orifice size selection (Pressures are approximate and serve only as a starting point).

Orifice size and pressure	Speed (MPH)						
	3	4	5	6	6	7	7
Orifice diameter (inches)	.020	.020	.024	.024	.029	.024	.029
Approximate pressure (PSI)	18	25	22	28	15	38	19

C. Number of seconds required for delivery of one quart from 4 or 6 injectors per row to obtain 20 gal/A broadcast spray volume at specified speeds.[3]

		Time for delivery of 1 quart from:	
		4 injectors	6 injectors
MPH	second/300 ft.	seconds/qt.	seconds/qt
2.2	93	169	112
2.4	85	155	104
2.6	79	143	96
2.8	73	133	88
3.0	68	124	82
3.2	64	116	78
3.4	60	109	72
3.6	57	103	68
3.8	54	98	66
4.0	51	93	62
4.2	49	88	58
4.4	46	84	56
4.6	44	81	54
4.8	43	77	52
5.0	41	74	50
5.2	39	71	48
5.4	38	69	46
5.6	37	66	44
5.8	35	64	42
6.0	34	62	42
7.0	29	53	36

[1] 13068 row feet equals one acre where rows are 40 inches wide.

[2] Consists of 2 bands, each of 6-inch width.

[3] Start with approximate pressure given in "B" above, and adjust until one quart is delivered in correct number of seconds.

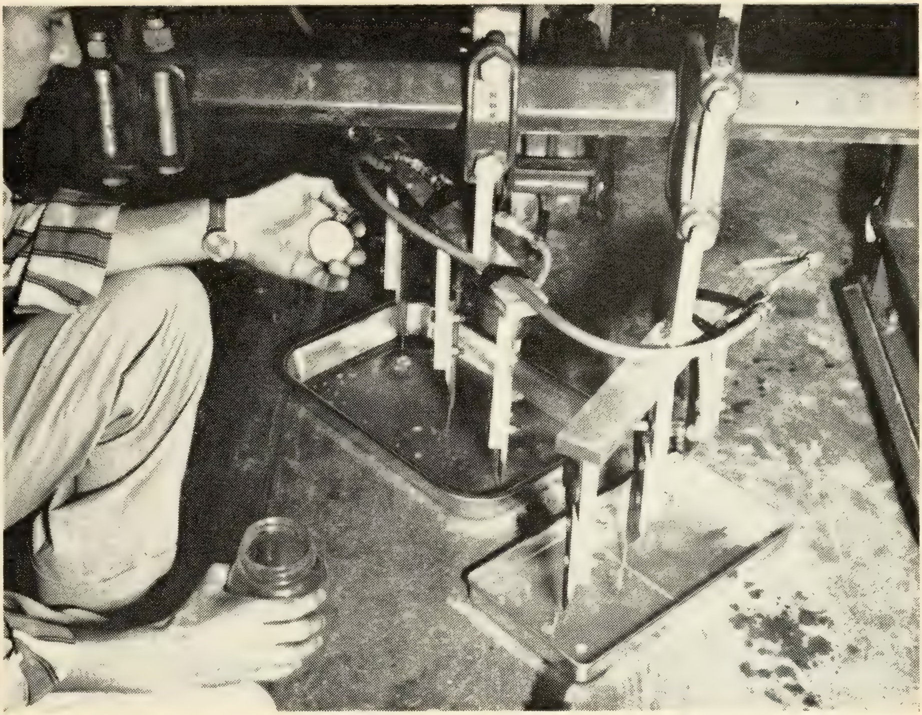

Figure 4. Method of calibrating injectors. Water from both pans should be poured into one quart jar for accurate measuring.

PRECAUTIONS

Pesticides, improperly used, may be injurious to man, desirable plants, and animal life. **Follow the directions and heed all precautions on the labels.** Stored pesticides should be kept in closed, well-labelled containers in a dry place. Store them where they will not contaminate food or feed, and where children and animals cannot reach them. Do not clean application equipment or dump excess pesticide where it will contaminate lakes, streams, ponds, or other water sources.

BULLETIN 724 APRIL 1966

SOCIOECONOMIC STATUS INDEXES FOR MISSISSIPPI COUNTIES

By ELLEN S. BRYANT

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SOCIOECONOMIC STATUS INDEXES FOR MISSISSIPPI COUNTIES

BY ELLEN S. BRYANT

Where does Mississippi's population stand in achievement on income, occupation, and education—the areas of activity which are most involved in the state's striving for full participation in America's high levels of living. Several series of socioeconomic indexes have been prepared from published and unpublished census data on these three criteria for Mississippi, her counties, and the nation. These indexes offer a basis for comparing economic achievement and general living levels within the state and between the state and the nation: they pinpoint the social aspects and the geographic area where there is the greatest need for progress. Thus they should be useful guides to many social planning and development agencies.

STATE AVERAGES

Mississippi's socioeconomic status (SES) indexes are generally lower than those for the nation, with total national averages exceeding those for the state by about 25 to 30 percent. Table I compares state and national socioeconomic indexes by residence classifications for total, white, and nonwhite populations. These indexes were constructed so as to fall between a minimum of zero and a maximum of 100.[1] It is apparent that the possible range of improvement is sizeable for both the state and the nation since all of the indexes are below 50. Overall, the urban and white indexes tend to be the highest in both the state and nation, while the nonwhite and farm indexes tend to be lowest. Total urban levels are about 30 percent higher than total farm levels. White urban levels are about 50 percent higher than both white farm and nonwhite urban levels and three times as high as those for the nonwhite farm population.

Table 1. Socioeconomic indexes for total, race, and residence populations, United States and Mississippi, 1960.

Population	United States	Mississippi
Total	42.8	32.5
Uurban plus rural nonfarm	43.8	35.6
Farm	29.3	22.3
White	44.4	41.3
Uurban plus rural nonfarm	45.8	43.9
Farm	30.8	30.0
Nonwhite	28.1	17.6
Uurban plus rural nonfarm	29.0	19.4
Farm	15.1	13.2

When race and residence factors are taken into account, socioeconomic achievement differentials between the state and nation are, in most cases, not as great as the total indexes suggest. In comparing Mississippi and the nation within the race and residence classifications it can be seen that differences are virtually nonexistent for the white population but are almost entirely confined to the nonwhite group. Mississippi's white populations compare very favorably with the national white averages. Even the two white farm populations have almost identical scores. The socioeconomic achievement of the farm population is generally low, but the situation is apparently not restricted to Mississippi. Both state and national white farm indexes are about 15 points below the white urban level but only a point or two ahead of the nation's nonwhite urban group.

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[1] An area within which every adult was a college graduate, earned (if working) at least $10,000, and had a high business or professional occupation, would be given the theoratically high score of 100. See the methodological explanation

The Mississippi Indexes for nonwhites, particularly in the nonfarm plus urban category, are noticeably lower than the national averages. Nonwhite urban scores in the nation average 50 percent higher than state level of 19. Extremely low socioeconomic indexes are shown for nonwhite farm populations in both the state and nation. Since most of the nonwhite farm population resides in the South, these measures essentially compare Mississippi with the rest of the South. Large differences would not be expected. In other parts of the nation, nonwhites tend to have urban residences. Mississippi's lower than national total socioeconomic index is undoubtedly the result from having large proportions of people in categories where socioeconomic achivement is generally low—the farming and nonwhite classes. The situation seems to be particularly acute where these two characteristics are combined.

Component Indexes

Further insight into state and national socioeconomic differences can be had by examining comparative achievement in the contributing index critera separately. The indexes given in Table I are a composite measure of all three socioeconomic variables. Separate indexes for occupation, income and education were also computed, and again in such a way as to place the scores between zero and 100 points. They may be seen in Table II.

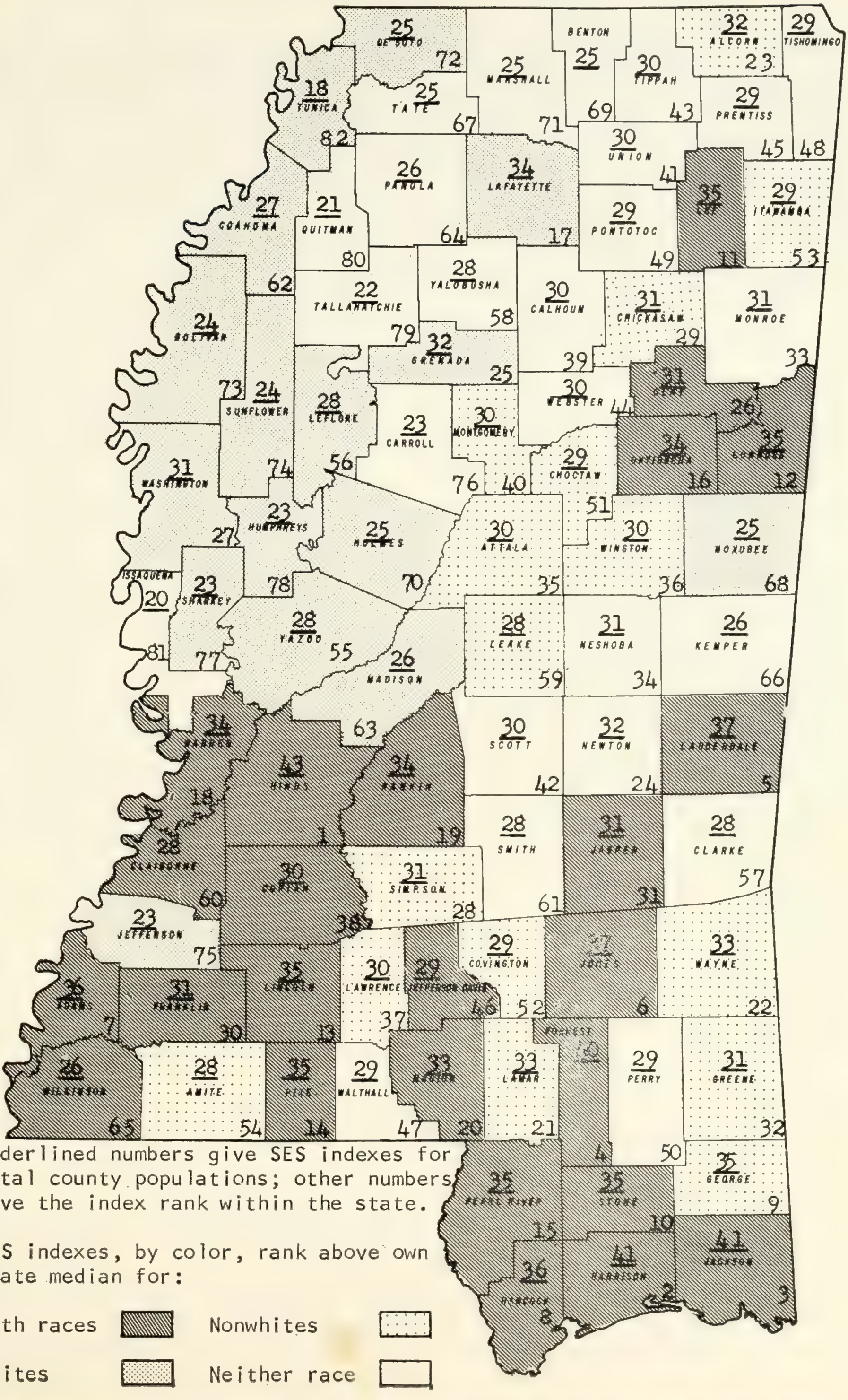
The first two of these—occupation and education indexes show several similarities in achievement between the state and nation, a few cases where the state achievement exceeds the national average and only one category where the state lags noticeably behind the nation.

First, the state's white nonfarm group scores slightly higher than the nation on both these indexes. Occupational and educational achievement of Mississippi's white urbanized population is ahead of the national average.

Second, the state's white farm population exceeds the nation in occupational achievement. This is because Mississippi has smaller proportions of her white farm residents of labor force age engaged in farming than does the nation and higher percents in white collar and

Table 2. Component indexes of socioeconomic status, by race and residence, United States and Mississippi, 1960.

Population	Residence Total	Urban plus rural nonfarm	Farm
	Occupation		
Total			
United States	56.2	57.9	34.6
Mississippi	47.0	51.5	32.0
White			
United States	58.1	59.9	35.6
Mississippi	56.7	60.7	40.1
Nonwhite			
United States	39.8	40.9	24.5
Mississippi	30.4	33.6	22.5
	Education		
Total			
United States	45.1	45.8	36.2
Mississippi	36.2	39.2	26.6
White			
United States	46.8	48.1	38.2
Mississippi	46.9	49.2	37.0
Nonwhite			
United States	30.1	31.0	15.6
Mississippi	17.2	18.7	13.4
	Income		
Total			
United States	27.1	27.8	17.2
Mississippi	14.4	16.1	8.3
White			
United States	28.6	29.3	18.6
Mississippi	20.2	21.9	12.8
Nonwhite			
United States	14.5	15.1	5.2
Mississippi	5.1	5.8	3.6


25 DE SOTO 72
25 MARSHALL 71
BENTON 25 69
30 TIPPAH 43
32 ALCORN 23
29 TISHOMINGO 48
18 TUNICA 82
25 TATE 67
29 PRENTISS 45
30 UNION 41
27 COAHOMA 62
21 QUITMAN 80
26 PANOLA 64
34 LAFAYETTE 17
29 PONTOTOC 49
35 LEE 11
29 ITAWAMBA 53
24 BOLIVAR 73
22 TALLAHATCHIE 79
28 YALOBUSHA 58
30 CALHOUN 39
31 CHICKASAW 29
31 MONROE 33
32 GRENADA 25
24 SUNFLOWER 74
28 LEFLORE 56
23 CARROLL 76
30 MONTGOMERY 40
30 WEBSTER 44
31 CLAY 26
34 OKTIBBEHA 16
35 LOWNDES 12
31 WASHINGTON 27
29 CHOCTAW 51
23 HUMPHREYS 78
25 HOLMES 70
30 ATTALA 35
30 WINSTON 36
25 NOXUBEE 68
ISSAQUENA 20 81
23 SHARKEY 77
28 YAZOO 55
26 MADISON 63
28 LEAKE 59
31 NESHOBA 34
26 KEMPER 66
34 WARREN 18
43 HINDS 1
34 RANKIN 19
30 SCOTT 42
32 NEWTON 24
37 LAUDERDALE 5
28 CLAIBORNE 60
30 COPIAH 38
31 SIMPSON 28
28 SMITH 61
31 JASPER 31
28 CLARKE 57
23 JEFFERSON 75
30 LAWRENCE 37
29 JEFFERSON DAVIS 46
29 COVINGTON 52
37 JONES 6
33 WAYNE 22
36 ADAMS 7
31 FRANKLIN 30
35 LINCOLN 13
26 WILKINSON 65
28 AMITE 54
35 PIKE 14
29 WALTHALL 47
33 MARION 20
33 LAMAR 21
40 FORREST 4
29 PERRY 50
31 GREENE 32
35 GEORGE 9
35 PEARL RIVER 15
35 STONE 10
36 HANCOCK 8
41 HARRISON 2
41 JACKSON 3

Underlined numbers give SES indexes for total county populations; other numbers give the index rank within the state.

SES indexes, by color, rank above own state median for:

Both races ▨ Nonwhites ⬚

Whites ▒ Neither race ☐

Figure 1. Socioeconomic Status Indexes for Mississippi Counties, 1960—Total Popu-

blue collar skills, most of which were weighted higher in the indexing procedure than were farming occupations. Fifty-eight and 46 percents employed white farm residents were farming in 1960 in the nation and state, respectively; for nonwhites these percents were 66 and 75 in the same order.

Third, it should be noted that, among the nonwhite farmers, occupational and educational achievement in the nation is only slightly ahead of the state.

Lastly, it is only among urbanized nonwhites where occupational and educational indexes differ greatly between the state and nation. Occupationally, national nonwhite achievement is one-third higher than the state; educationally, national achievement was about 70 percent higher than in the state.

On the income index different patterns emerge. First, these indexes tend to cluster at lower levels than those for occupation and education. Ranging from a low of 4 to a high of 29 they are, in fact, surprisingly lower than the possible maximum of 100. Again the urban and white indexes are found at the upper levels of the range while the farm and nonwhites scores are lowest. Second, in comparing the state and nation it is apparent that it is on income that Mississippi lags significantly behind the national average. Sizeable discrepancies exist between the state and nation for all race and residence groups.

Most of the Mississippi categories have achieved from one-half to two-thirds of the comparable national income index. For urbanized nonwhites in Mississippi, the index is only one-third that of the national average. Mississippi's nonwhite farm income index is ever lower—an abysmal 3.6, while nation's nonwhite farmers (actually the South) are only slightly higher and about equal to Mississippi's urban nonwhites. Even the white farm income indexes are distressingly low in Mississippi. The indexes show that incomes for Mississippi's white farm residents, many of whom are not engaged in farming, average below those for the nonwhites in national urbanized areas.

On the basis of these indexes we can conclude, without dispute, that Mississippi's low levels of living are an outgrowth of low educational achievements among her nonwhite population and low incomes among both farm and nonwhite residents.

COUNTY INDEXES

County socioeconomic indexes show a considerable range of variation within the state, but the patterns observed above for the state tend to persist at the county level. White and urbanized segments of each county's population score relatively high, while the farm and nonwhite populations score low in most cases. The complete listing of SES indexes for counties by residence and color is given in Table IV. The map, Figure I, shows the average (total population) county indexes, the rank of these indexes within the state, and a county typology based on the comparative rank of each county's component race indexes. The indexes are shown as underlined figures on the map; the rank of the index is placed in the lower right hand corner of the county. Fractional differences between mean indexes and the range of differences between component indexes were used to assign rank where identical indexes are shown.

An indication of the range of socioeconomic status (SES) within the state can be had by a casual examination of the high and low ranks on the various indexes. Highest ranking county on the mean index (Total-total column) is Hinds County with 43; the lowest in Tunica with 18. Highest score among all the race and residence indexes is 54, found among urbanized white persons in Hinds County. Hinds, as might be expected, also has the highest total white score in the state. Top farm population score is 48.7 in Adams County. This score exceeds the state mean and is surprisingly close to the top urbanized score in the state. High scores among nonwhites are found among farm residences in Jackson County and urbanized populations in Hinds, Harrison and Jackson Counties, all of which earned approximately 24 on the index.

Lowest score in the state is 8.9 found among nonwhite farmers in Leflore County. Needless to say this is also the state nonwhite and state farm low. The urbanized low is 12.5 for nonwhites in Tallahatchie County. Lowest white score is among farmers in Tishomingo where the index is 24. In nearby Alcorn County, white scores are only slightly higher. The socioeconomic level of many white farm people in the northeast corner of the state is no higher than that for nonwhites in the most urbanized areas of the state. The white urban low is 32, found in Itawamba just south of Tishomingo.

County Typology by Race

The county typology of comparative racial achievement on the SES indexes shown in Figure I is based on the percentile rank of counties on separate color-SES indexes. Four types are designated:

In the first, a high-high type, the county's white population ranks above the state's white median county score of 37.95, and its nonwhite population above the state nonwhite median county index of 17.55.

The second type, a high-low, has above median rank for whites and a below median rank for nonwhites.

Third, a low-high type, designates counties which have a white index below the white median and an above median nonwhite index.

In the fourth type, the low-low, both racial groups rank below their respective state medians.

Although this SES-race typology is methodologically crude and a more refined differentiation would be more accurately descriptive of county variations, it does delimit an interesting and meaningful geographical pattern. It also indicates the value of controlling for significant factors when developing population measurements and indexes.

Type I counties, or those with better than average SES achievement for both races, are located chiefly in the southern half of the state and in areas with sizeable urban-industrial developments. The Jackson-Vicksburg area, Natchez, McComb, the Gulf Coastal area, Hattiesburg, Laurel, Meridian, Tupelo, and the Columbus-Starkville-West Point triangle are included in this type. Thus high SES levels again seem to be tied to urban life. High proportions or urban residences tend to yield high average index scores.

Table 3. Percent of counties in each SES-Race county type exceeding Race-Residence index medians

		Percent counties exceeding the median for			
County type	N =	Urbanized white	Farm white	Urbanized nonwhite	Farm nonwhite
All	(82)	66	55	54	55
1 (high-high)	(25)	76	96	88	84
2 (high-low)	(16)	100	69	25	----
3 (low-high)	(16)	13	31	81	94
4 (low-low)	(25)	28	20	20	36
(Median index)		(41.1)	(30.6)	(18.6)	(14.8)

Table 4. Socioeconomic status indexes of Mississippi counties, by residence and race.

Mississippi Counties	Total			Urbanized (Urban & rural nonfarm)			Farm		
	Total	White	Nonwhite	Total	White	Nonwhite	Total	White	Nonwhite
Adams	36.3	49.2	21.6	36.6	49.3	21.8	30.2	48.7	16.1
Alcorn	31.9	33.7	19.3	34.7	36.9	20.6	23.8	24.7	12.1
Amite	28.4	37.5	17.9	29.8	40.0	17.6	26.4	33.5	18.5
Attala	30.4	37.6	18.1	34.3	41.4	20.1	23.3	29.2	15.2
Benton	25.2	31.1	13.5	30.3	33.8	14.0	21.8	28.5	13.3
Bolivar	23.7	39.5	13.7	30.6	45.0	17.5	14.1	25.6	10.0
Calhoun	29.9	33.0	16.6	33.8	37.1	19.1	23.9	27.3	13.3
Carroll	23.2	33.1	13.0	27.6	37.5	14.0	19.7	28.4	12.3
Chickasaw	30.9	36.5	18.6	33.6	38.7	19.6	24.8	30.3	17.2
Choctaw	28.9	32.4	17.8	31.0	35.9	17.8	25.2	26.9	17.9
Claiborne	27.8	45.2	19.6	29.4	48.4	21.0	21.8	34.8	14.2
Clarke	28.1	33.7	16.3	29.5	35.6	16.7	22.6	29.6	13.0
Clay	31.4	42.4	18.2	33.9	44.7	19.3	23.7	33.3	15.6
Coahoma	26.6	46.6	14.9	30.0	48.0	16.9	14.4	35.1	10.0
Copiah	30.1	39.9	17.9	31.4	41.2	19.0	25.9	35.3	14.2
Covington	28.8	33.0	18.2	32.2	36.9	18.6	25.3	28.7	17.9
DeSoto	24.9	39.2	12.9	28.1	41.1	13.0	20.1	34.5	12.8
Forrest	40.0	46.7	22.1	40.2	47.1	22.2	32.1	34.9	18.7
Franklin	30.8	38.6	17.8	31.3	40.3	18.0	29.0	31.9	16.4
George	35.4	37.2	19.6	36.5	38.8	19.5	32.7	33.3	21.3
Greene	30.7	33.6	19.5	30.4	34.0	19.4	31.8	32.5	19.9
Grenada	31.7	43.1	16.8	34.1	44.6	18.2	20.9	33.2	12.2
Hancock	35.5	38.0	22.2	35.7	38.5	22.3	32.8	33.1	----
Harrison	41.2	44.7	24.0	41.2	44.8	24.0	35.7	36.4	11.4
Hinds	43.0	53.9	23.2	44.3	54.2	24.0	22.9	40.9	14.8
Holmes	25.2	43.2	14.9	29.1	46.0	16.3	17.4	32.8	12.8
Humphreys	22.6	39.1	13.0	23.8	41.9	13.5	18.8	30.4	11.2
Issaquena	19.7	32.8	10.9	19.2	33.9	9.1	20.5	31.9	12.9
Itawamba	28.7	29.2	17.9	31.0	31.8	18.1	25.0	25.3	17.5
Jackson	40.9	44.6	24.2	40.9	44.7	24.2	37.9	38.2	24.5
Jasper	30.8	38.7	18.9	32.2	40.7	20.2	28.3	35.4	16.4
Jefferson	23.4	40.8	14.6	23.9	42.5	14.7	22.4	36.6	14.5
Jefferson Davis	29.4	38.4	18.9	34.2	42.3	20.4	24.1	32.0	17.9
Jones	37.0	41.8	21.0	37.6	42.9	21.3	31.2	33.7	16.4
Kemper	25.8	36.3	16.0	31.3	41.7	18.3	21.9	31.3	14.8
Lafayette	34.4	42.0	16.8	39.4	47.0	19.2	22.1	28.1	14.2
Lamar	33.3	35.8	18.6	34.7	38.0	18.7	28.6	29.2	17.7
Lauderdale	37.2	44.8	20.5	37.6	45.2	20.8	28.7	35.4	16.4
Lawrence	30.1	35.2	17.8	31.8	37.7	18.6	26.8	30.6	15.6
Leake	28.0	33.1	17.7	33.5	38.2	20.2	23.7	25.3	16.4
Lee	35.4	39.6	19.9	38.1	42.4	21.5	24.8	28.1	15.5
Leflore	28.3	46.9	15.0	35.1	49.3	19.6	12.9	30.9	8.9
Lincoln	34.9	40.4	20.3	35.6	42.1	20.7	31.0	33.4	15.5
Lowndes	35.1	44.7	17.7	37.2	46.1	18.8	24.2	34.5	13.8
Madison	26.4	44.4	16.3	30.6	46.4	18.7	18.5	37.0	12.8

(Cont'd.)—Table 4. Socioeconomic status indexes of Mississippi counties, by residence and race.

Mississippi Counties	Total			Urbanized (Urban & rural nonfarm)			Farm		
	Total	White	Nonwhite	Total	White	Nonwhite	Total	White	Nonwhite
Marion	33.4	38.6	19.6	36.0	41.1	21.4	26.3	31.3	15.6
Marshall	25.1	37.8	17.1	31.4	41.1	21.9	18.0	30.5	14.6
Monroe	30.6	36.2	17.5	32.7	37.8	18.8	24.6	30.5	14.8
Montgomery	29.9	37.0	17.8	32.6	39.7	19.1	24.2	30.5	15.4
Neshoba	30.5	34.1	17.6	33.9	38.0	19.5	25.6	28.4	14.6
Newton	31.8	37.3	17.5	34.7	41.1	18.4	26.6	30.6	15.9
Noxubee	25.4	43.2	15.1	32.2	46.2	17.1	18.7	35.8	14.0
Oktibbeha	34.3	45.3	17.8	36.6	46.7	18.0	25.0	36.1	17.1
Panola	26.2	37.6	13.8	33.4	43.6	17.6	18.2	28.0	11.7
Pearl River	34.5	38.2	20.4	34.6	38.9	20.5	34.3	35.1	17.1
Perry	29.1	33.4	16.8	29.3	34.6	17.1	28.3	30.6	15.5
Pike	34.6	43.7	20.0	35.5	44.6	20.3	28.2	36.4	18.1
Pontotoc	29.3	31.6	16.0	33.3	36.4	17.0	25.2	26.8	14.6
Prentiss	29.3	31.1	14.6	32.8	35.0	14.9	25.0	26.4	14.4
Quitman	21.0	34.2	11.4	25.1	41.3	12.8	15.9	24.7	9.9
Rankin	33.8	40.9	19.0	35.1	41.8	20.0	27.7	35.8	16.4
Scott	29.7	35.5	16.9	32.6	38.8	17.9	24.4	29.1	15.3
Sharkey	22.9	41.7	13.1	31.7	50.0	16.6	14.7	27.2	10.6
Simpson	31.3	36.0	18.7	34.0	38.8	19.4	25.5	29.4	17.7
Smith	27.6	29.7	17.0	31.6	33.9	18.2	24.3	25.9	16.3
Stone	35.3	40.2	19.9	35.3	40.8	19.8	34.9	36.9	20.7
Sunflower	23.7	39.7	13.3	25.9	42.7	14.5	17.5	30.6	10.3
Tallahatchie	21.5	34.7	11.8	23.7	38.7	12.5	17.9	27.9	10.8
Tate	25.3	36.6	13.3	32.5	42.5	15.5	18.9	28.5	12.1
Tippah	29.6	31.7	16.4	35.5	37.8	18.7	24.0	25.6	14.9
Tishomingo	29.2	29.7	17.4	31.8	32.6	16.8	24.1	24.2	18.6
Tunica	18.0	39.1	10.9	24.4	45.1	12.5	13.0	29.3	9.9
Union	29.7	31.9	16.7	33.2	36.4	17.6	24.4	25.6	14.0
Walthall	29.4	35.9	16.9	33.2	41.9	16.2	26.0	30.6	17.4
Warren	34.2	46.4	20.2	34.3	46.3	20.3	21.5	32.3	15.7
Washington	31.4	47.3	17.0	32.6	47.9	17.7	19.2	36.4	11.5
Wayne	32.5	37.9	19.7	33.4	39.1	20.6	29.6	34.4	16.2
Webster	29.6	33.4	15.2	31.5	36.6	16.8	24.9	27.9	13.0
Wilkinson	25.9	40.2	17.7	26.9	40.7	18.2	22.4	38.2	16.3
Winston	30.2	36.6	18.5	34.3	42.6	19.9	24.4	28.6	16.6
Yalobusha	28.2	35.5	14.6	32.3	38.4	16.1	21.3	28.7	13.2
Yazoo	28.3	42.8	15.0	32.3	46.0	16.8	18.9	31.4	12.1

Since the county indexes were prepared for residence as well as race groups, it is possible to compare farm and non-farm indexes for each county race type. These comparisons reinforce the importance of urbanization and permit further explanation of mean score levels. As is shown in Table III, only six of the group—the less urbanized counties in South Mississippi — dropped slightly below the 41.1 average for white urbanized scores, and only three were below the median nonwhite urban index of 18.6.[2]

Type I counties also tend to rank above average on the farm as well as the urbanized indexes. Table III shows that only one of the twenty-five counties in this type (Lee), falls below the median white farm index of 30.6 and only four (Claiborne, Copiah, Harrison and Lowndes) fall below the median nonwhite farm index of 14.8. The preponderance of above average index scores for all four race-residence groups in Type I contributes to the inclusion of a few counties (Claiborne, Wilkinson, and Jefferson) with comparatively low mean county scores and ranks but high component indexes by race. The explanation lies mostly in the high proportions of nonwhites in these counties. In the order mentioned they have 76, 71 and 55 percent of nonwhites. Even when nonwhite achievement is comparatively high in socioeconomic factors, it lags sufficiently behind the white levels to sizeable deflate a mean score where they compose a high proportion of the population. In spite of low mean county scores, the socioeconomic level of living for both races in these counties compares favorably with the most developed areas of the state. Noticeably absent from Type 1 are the urban centers in the Delta counties containing Greenville, Greenwood, and Clarksdale.

Type II, the high-low, dominates in the Mississippi Delta and characterizes 16 of the state's 82 counties. In these, the proportion of the population which is nonwhite often exceeds the white, and much of this Negro population is engaged in the large scale farm operations of the Delta which have extensive Negro labor requirements. Nonwhite farm SES indexes are predominately low in Mississippi and the South The nonwhite farm indexes in this group are all below the state average and six have scores of 10 or less. In addition, the urbanized nonwhite indexes for these counties are mostly either very low or below average. Only Grenada, Lafayette, Leflore, and Madison counties in the group have higher than average nonwhite urban indexes. In contrast, the white indexes by residence show that urbanized whites in counties all rank above average, while about one-third (5) of the counties have white farm resident groups scoring below average. These five are Bolivar, Humphreys, Lafayette, Sharkey, and Tunica.

Another sixteen counties fall into Type III, the low-high, and have lower than white average achievement among whites and higher than nonwhite average ranks among nonwhites. However, while nonwhite levels are above average, they tend to cluster close to average and none of the 11 counties with total nonwhite SES indexes over 20 are included in the group. All of these are Type I counties.

Although Type III's are the least urbanized of all four types, none of the low-high counties are in the Delta, but are geographically scattered north to south, roughly in the eastern half of the state, and frequently adjacent to counties of the high-high type. Two-thirds of the low-highs have nonwhite proportions below the state mean of 42.3 percent. Fifteen of the 16 have above average nonwhite farm indexes. One of the three county nonwhite farm indexes over 20 is in this type, and in only one county of the type, Alcorn, does this particular index fall below 15. Above average nonwhite urban indexes also predominate in the low-high group; only three are below 18.6—Amite, Choctaw, and Itawamba.

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[2] These were Franklin, Hancock, Jasper, Pearl River, Stone and Wilkinson for the white and Franklin, Oktibbeha and Wilkinson for the nonwhite.

On the other hand, Type III counties do not have their proportional share of the best nonwhite urban indexes. Out of 22 nonwhite urban indexes which are 20 or better, only four fall in this type. Eighteen are found among the twenty five counties in the high-high group. Thus in counties where nonwhite SES levels are above the nonwhite average the white SES levels below the white average, the better than average nonwhite achievement tends to be somewhat more selective of the farm rather than of the urban situation. The low rank of the white scores in this type seems to be attributable more to below average achievement in the urbanized population rather than among the farm people. Only two of these counties (Attala and Winston) have a better than median score for their white urbanized segments. None of the other three types had so few counties with high scores in this subgroup. Besides Attala and Winston, only one other county — Alcorn — has a city of 5000 or more. Five counties (Amite, George, Greene, Lawrence and Wayne) have average or better white farm scores.

Twenty-five counties have lower than average SES indexes for both of their racial components and make up Type IV or low-low type. These counties tend also to be selective of the least urbanized counties and are located in some of the more remote areas of the State. Sixteen are in roughly the northern third of the state. Seven of the remainder are in the Central Hills areas. Only four have cities as large as five or six thousand—Marshall with Holly Springs, Monroe with Amory and Aberdeen, Union with New Albany, and Neshoba with Philadelphia. This group is rather evenly divided between counties of high and low proportions nonwhite. Those in and bordering the Delta have high percents of nonwhites, while those in the hill areas are predominately white. Achievement levels are almost universally low for all four race-residence groups of this type, but the poorest comparative showings are among the white farm and nonwhite urbanized subgroups. Only five of the twenty-five counties has white farm indexes above the 30.6 median and only five others nonwhite urbanized indexes over the 18.6 median; seven exceeded the white urbanized average; nine ranked above the median nonwhite farm score.[3]

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[3] In the subgroup order mentioned these were: (1) Issaquena, Kemper, Newton, Perry, and Walthall; (2) Calhoun, Marshall, Monroe, Neshoba, and Tishomingo; (3) Kemper, Marshall, Newton, Panola, Quitman, Tate, and Walthall; (4) Kemper, Monroe, Newton, Perry, Scott, Smith, Tippah, Tishomingo, and Walthall.

CONSTRUCTION METHOD

The socioeconomic status (SES) indexes were constructed from both published and unpublished 1960 Census data. They were computed by color for the total population, the farm, and the urban plus rural nonfarm populations, making a total of nine indexes which were constructed for the race and residence populations of each of Mississippi's 82 counties, the state, and the nation. The population residence classification was dichotomized between farm and urbanized (urban plus rural nonfarm) populations rather than by the more traditional urban and rural designations because the unpublished Census data on counties was tabulated in this way. While this farm-nonfarm break is somewhat of an innovation in population statistics, it is nevertheless logical. One would expect more similarity between the urban and rural nonfarm groups in education, occupation and income than between the rural farm and rural nonfarm people.

The criteria by which the county socioeconomic levels were measured were education, income and occupation. Specifically, these were measured by (1) years of school completed by those aged 25 and over, (2)income of persons aged 14 and over, and (3) occupation group of employed persons. Three main reasons determined the choice of these measures in determining socioeconomic status of Mississippi counties. First, data on them by county was available from unpublished Census material; second, their relationship to socioeconomic status is an established and accepted fact[4]; and third, a procedure and weighting system for combining them into a socioeconomic index was available from the work of Charles B. Nam and his staff at the Population Division of the Census Bureau.[5] The Census Bureau procedures used these same variables in determining socioeconomic characteristics for a sample of the national population from the 1960 Census. The indexes described in this report were derived by using the same scoring and weighting procedures as the Census measures. They differ from them chiefly in that they were computed from grouped data as averages for a county while the Census indexes were computed from individual and family ratings and later categorized to show the distributional range of the socioeconomic level for particular regions and segments of the national population. [6]

The construction procedure consisted of computing separate income, education, and occupation indexes for each group in the county and averaging these three component indexes to get the socioeconomic indexes. Several steps were necessary. First the frequency distribution for each county group on each variable was obtained. Second, the frequency for each category was multiplied by a weighted score. Third, the category products and category frequencies were summed separately and the product sums divided by the frequency sums to obtain the component income, education and occupation indexes. These were then averaged. The score weights assigned to and multiplied by each category frequency were the average percentile ranks of each particular category in the cumulative frequency distribution of the national population on the specific variable measured. For instance, if those in the total U. S. population completing from one to three years of college had an average percentile rank of 80 in the amount of education completed, a score of 80 was assigned to this category.

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[4] These variables are thought to provide the economic and social base for the development of a particular consumption pattern and life style level. The work of Warner, The Lynds, Kahl, and Centers all emphasize the importance of these variables. See, for instance: W. Lloyd Warner, Marsh Meeker, and Kenneth Eels, **Social Class in America** (Chicago: Science Research Associates, 1949). Income, education, and occupation seem both separately and in combination to be indicators of socioeconomic status, but taken together they presumably provide a better indicator of generalized socioeconomic level than any one of them alone. They are in fact related to each other. Rank order correlation coefficients of .78 between education and income, .84 between education and occupation, and .86 between income and occupation were obtained from the data used in the Mississippi county indexes. These were similar to the correlations found by Warner for these same variables. See Warner, et al, **op. cit.,** 172.

[5] U. S. Bureau of the Census, **Methodology and Scores of Socioeconomic Status**, Working Paper No. 15 (Washington, D. C., 1963), 1.

[6] U. S. Bureau of the Census, "Socioeconomic Characteristics of the Population: 1960," **Technical Studies, Current Population Reports** P-23, No. 12 (Washington, D. C.: July 31, 1964), 2-6.

A somewhat more involved procedure was used to obtain the occupational score weight. For each occupational category, the average percentile rank on education and on income for those in the category were averaged to get the score weight. If, for instance, carpenters had an average percentile rank of 50 on education and an average percentile rank of 60 on income, the occupation score weight for carpenters would be 55. Theoretically, the top score weight obtainable would have been 100. However, since category averages were used, no score weight was this high. Highest score weights used were 90 for professional, 95.5 for those with four years or more of college, and 82 for those with incomes of $10 thousand or more. A group having all its residents in these three categories would have scored 89 on this index. Because category averages were used as score weights, the theoretically top score of 100 could not have been assigned to any community. A community with a perfect, normal-curve frequency distribution on these variables would have earned a SES index of 50.

SUMMARY AND CONCLUSION

Mean socioeconomic status levels in Mississippi, both for the state and the individual counties, tend to fall below national socioeconomic averages. However, detailed analyses of component and county populations scores reveal that there are many areas and populations in the state where socioeconomic achievement is relatively high and others where it is distressingly low.

Socioeconomic status (SES) indexes were prepared for Mississippi counties, the state, and the nation using data on three criteria—education, income and occupation. Separate indexes were prepared for white urbanized, white farm, nonwhite urbanized and nonwhite farm groups. Nine indexes including the four component race-residence groups and five sub-total and total groups were prepared for each geographic area. These indexes provide an informative description and comparison of the socioeconomic levels of several types of population in Mississippi and her counteis. Their presentation in this report is to provide accurate, practical descriptive material on Mississippi counties. However, future applications of the indexes may produce casual explanations of various county phenomena.

Comparison of the race-residence indexes on the state level reveals that urbanized and white populations tend to have comparatively high indexes while farm and nonwhite groups fall at the lower ranks of the indexes. When compared with national averages the most pronounced lag in Mississippi on the three criterion indexes is on income, which in some cases is only about one-third of the comparable national average. On occupation and education Mississippi's white urbanized population scores slightly above the average for the comparable national group.

Extensive variations in SES indexes exist both among and within counties, but in general the state pattern is duplicated at the county level. A typology of counties based on comparative SES rank within the color components of the county populations was able to delimit a meaningful geographic pattern of levels of socioeconomic achievement in the state.

Identified by the typology were urban-industrial complexes (Type I); most of the Delta (Type II) and the highly rural and hill counties (Types III and IV).

The first which is predominately found

in South Mississippi has above average socioeconomic indexes for both racial groups, includes the highly urbanized centers, but also some counties with high proportions nonwhite and comparatively high proportions farming.

The second type, chiefly found in the Delta, was most distinguished by high SES indexes among urbanized white residents, comparatively low indexes for white farmers, and very low indexes for both farm and urbanized nonwhites.

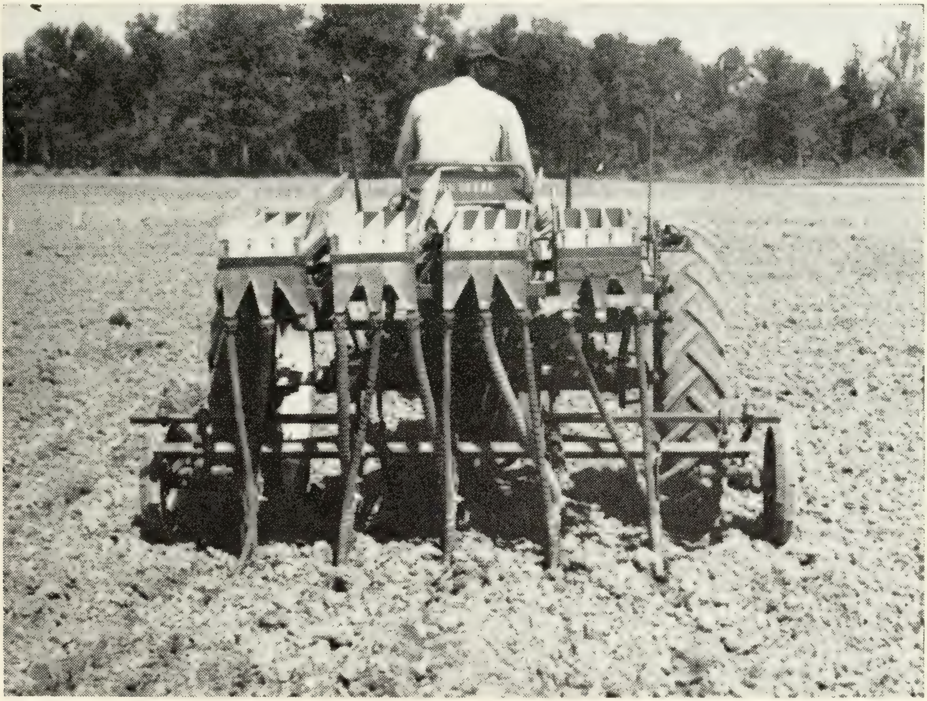
Types III and IV both had white socioeconomic scores ranking below the white median. The two differed in that Type III had nonwhite scores above the nonwhite median while IV had below median scores for both racial segments. While both of these types are highly rural, Type III (low-high) is the least urbanized. Two-thirds of these counties had no urban population in 1960; half of the Type IV's did not. Other differentiating features of the low-high's were low proportions nonwhite, almost universal, above average SES achievement for both nonwhite residence groups and more below average scores for urbanized white than for farm white.

Of all the types, Type III counties had the best comparative showing for nonwhites—particularly for farm nonwhites—and the poorest showing for whites—particularly urban whites. Type IV's had a noticeably better record for whites than the preceding group, and a better standing for nonwhites than the high-low Type II group.

While the patterns discernable in the above typology are suggestive, they will not permit firm conclusions. Partial exceptions to the general trend exist in every type. Some counties with high nonwhite proportions seem to have generally depressed nonwhite socioeconomic situations. Others with equally high proportions do not. Similar statements may be made about farm populations. While most farm indexes are relatively low, a few fall at the upper farm index levels. Further analysis using simultaneous control of complicating variables is necessary to interpret the casual meanings of the differential index ranks in Mississippi. For the present they are useful for pinpointing areas of greatest developmental need.

BULLETIN 725 APRIL 1966

Higher Forage Yields With Closer Row Spacing



Mississippi State University

AGRICULTURAL EXPERIMENT STATION

HENRY H. LEVECK, Director

STATE COLLEGE MISSISSIPPI

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Summary

The closer row spacings produced higher yields with all forages. Data indicate that the closer the spacing the greater the yield.

Narrow row spacings present a problem with equipment for seeding, cultivating, and harvesting forage. By proper use of chemicals, cultivating may be greatly reduced or eliminated.

Seeding may be accomplished with equipment now available if the row spacing is not less than 16 inches. However, harvesting presents a problem which requires additional research.

On the cover:
Figure 1. Machine for accurate seeding and fertilizer application of experimental field plots.

HIGHER FORAGE YIELDS WITH CLOSER ROW SPACING

BY T. N. JONES

An increase in production of quantity and quality forage is desirable to meet the demands of the growing livestock industry in this area. Since production of livestock will continue to be highly competitive, the economical production of quality forage is of great importance. It is generally recognized and accepted that the utilization of home grown forage is the cheapest source of energy and protein for ruminant animals.

Crop row spacings narrower than 40 inches have interested researchers for many years. Most of the research work pertaining to narrow rows has been conducted in the corn belt with corn. Recent experiments show that by reducing the row width for forage crops in general from 40 to about 20 inches and doubling the distance between each plant in the row, an increase in yield may be expected. Today, 18 to 20 thousand plants per acre are recommended or twice the number previously used. This doubling of population means that twice as many plants are squeezed into the row. In other words, with 40-inch rows and 20 thousand plants or more per acre, the plants may be crowded in the row. One way to reduce crowding between plants in the row and make better use of the space between rows without changing population-per-acre is to decrease row width.

Equipment for Seeding Field Plots

In 1962, a study was initiated using four selected forages and seven row spacings to determine the influence on yield of the narrow row spacings.

It became evident early in the studies that the commercial equipment available was not accurate enough for applying seed and fertilizer for the field plot work. An experimental machine was built for this work. It consists of four endless belt hoppers, a toolbar with gauge wheels, permitting wide variations in row spacing. Each hopper is divided into three equal troughs. This permits using up to six boots or applicators at one time. This provides a trough for seed and one for fertilizer for each of the six applicators. The four hoppers are driven from a shaft which has a hand clutch built into the drive. Each belt is equipped with adjusting screws to assure continuous drive of all belts.

The experimental machine is set up to turn the endless belts one-half round in 21 feet of forward movement, by the tractor on the ground, thus dumping all seed and fertilizer from the belts in this distance. For experimental procedure, an 18' plot is harvested, cutting off 18 inches on each end of the plots, eliminating any drag in the equipment. The only human element left in the machine is that of placing the seed and fertilizer evenly on the belts. The upper part of the hopper is made of clear plastic materials, so the operation of the machine, seed and fertilizer is visible at all times.

The material from each trough falls into a separate flexible hose and is carried directly to the applicators. The applicators may be spaced at any desired row width on the toolbar.

In planting test plots, accuracy is the major objective. At the same time speed is desirable. To maintain accuracy and still obtain fair speed the following method of measuring the amount of seed and fertilizer has been found satisfactory. Determine by weight the amount of seed and fertilizer to be placed per row. Then make or cut a cylinder or container which will hold this exact amount when filled and leveled off across the top. These containers must be marked to identify them readily with the material with which they will be used. In a test of row spacing of four forages, seven row spacings and two seeding and fertilization rates were used. This test replicated eight times, just under 600 plots, required detailed planning not only for planting and producing but also for obtaining data during production and harvesting.

This machine has many possible uses in research, such as studies on fertilizer placement, rate, and seeding of crops. The endless belts will handle any type of seed, fertilizer, or combination of the two.

Four Forages Tested

The objectives of these tests with four forage crops was to determine if the narrow row spacing would significantly increase the yield of forage per acre. If increases were obtained by the narrow row spacing, then a major machinery problem of harvesting was involved and agricultural engineering research could be directed to this problem.

Two other factors were incorporated in the test, namely rate of seeding and fertilization. Row spacings were 16, 20, 24, 28, 32, 36, and 40 inches. The forages selected for the test were grain sorghums RS-610 and FS-1A, sorghum Dekalb 50B, and corn Pioneer. Each row spacing combination received two treatments as follows: Treatment 1, a given amount of seed and fertilizer per acre and Treatment 2, a given amount of seed and fertilizer per row regardless of row spacing.

The test was laid out in a standard lattice design with each treatment having seven replications. The two grain sorghums and the sorghum produced two crops each year from one seeding, while corn produced only one.

Each year after the plots were seeded, a chemical for weed control was applied broadcast as a spray. None of the plots received any cultivation or additional fertilizer.

Results Row Spacing Test 1962-65

Grain Sorghum RS-610: Table 1 shows results obtained with this crop. Row spacing is the only variable in Treatment 1. By reducing the spacing from 40

Table 1. Yield of RS-610 grain sorghum in row spacing test at State College, Mississippi.

Row space	1962	1963	1964	1965	Average	Percent increase over 40"
		Pounds of dry matter per acre				
Treatment 1: Set amount of seed and fertilizer per acre						
16"	16,662	14,701	17,968	12,277	15,402	70
20"	15,290	14,767	12,545	11,853	13,614	50
24"	13,504	13,939	13,286	8,668	12,349	36
28"	12,975	12,228	12,881	8,704	11,697	29
32"	12,415	11,189	9,311	6,158	9,768	14
36"	10,817	11,689	8,712	6,230	9,362	3.0
40"	10,781	10,781	9,017	5,798	9,094	-----
Double rows		12,153	5,750	-----	8,951	2.0
Treatment 2: Set amount of seed and fertilizer per row						
16"	20,092	17,642	20,582	12,839	17,789	94
20"	16,858	18,034	13,329	11,104	14,831	62
24"	16,226	14,157	12,850	8,382	12,904	41
28"	13,908	13,161	13,815	7,711	12,149	33
32"	13,313	11,598	9,474	5,827	10,053	10
36"	10,600	12,387	8,567	6,516	9,518	4.0
40"	11,042	10,912	9,017	5,653	9,156	-----
Double rows		14,375	6,403	-----	10,389	13

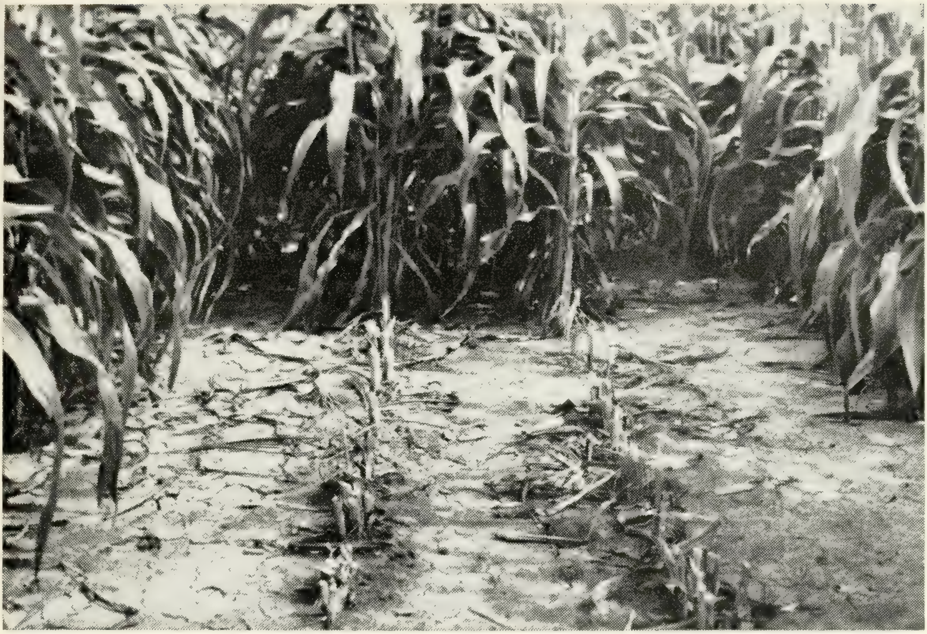

Figure 2. Good weed control was obtained by broadcast chemical treatments immediately after planting.

inches to 16 inches, the yield of forage was increased 6,308 lbs. dry matter per acre, or 70 percent. One of the big increases in yield, 21 percent, is between 32- and 28-inch spacing. The other big increase, 20 percent, is from 20- to 16-inch spacing. It may be observed that the yield increased progressively as the row spacing was reduced.

The statement for the two treatments must be understood before these data become of any value. For **Treatment 1,** the statement is as follows: "Set amount of seed and fertilizer per acre". For **Treatment 2,** the statement reads, "Set amount of seed and fertilizer per row regardless of spacing", which means fertilizer (13-13-13) as follows: 40- and 36-inch rows, 400 lbs.; 32- and 28-inch spac ing, 800 lbs.; and 16-inch, 1000 lbs. per acre.

The increase in yield for **Treatment 2** using RS-610 was from 9,518 lbs. on 40-inch spacing to 17,789 lbs. on 16-inch spacing or 94 percent. How much of this was due to row spacing, and how much to increase in fertilizer? The 40-inch spacings for the two treatments should theoretically be the same and in this test they were close: therefore, by subtracting percent increases, it is found that a 250 percent increase in fertilizer gave 24 percent increase in yield. The $22.50 invested in fertilizer gave a return of 2,387 lbs. of dry forage worth $24.35. Costs of seedbed preparation, cultivation, and chemicals do not change, regardless of yield. With higher yields, less acres would be needed to produce the required forage.

Grain Sorghum FS-1A: Yields of this crop are shown in Table II. In Treatment 1 reduction of row spacing from 40 inches to 16 inches gave the following yields: for 40 inches, 14,374 lbs.; for 16 inches, 21,510 lbs. or an increase of 50

Table 2. Yield of FS-1A grain sorghum in row spacing test at State College, Mississippi.

Row space	1962	1963	1964	1965	Average	Percent increase over 40"
		Pounds of dry matter per acre				
Treatment 1: Set amount of seed and fertilizer per acre						
16"	22,542	17,478	22,689	23,332	21,510	50
20"	22,085	15,682	19,602	22,922	20,073	40
24"	21,018	15,028	18,295	25,771	20,028	39
28"	17,082	11,948	16,802	19,630	16,366	14
32"	18,050	12,170	13,558	17,305	15,271	6.0
36"	17,206	12,342	13,213	18,834	15,399	7.0
40"	16,531	11,761	16,074	13,211	14,394	--
Double rows		13,852	12,153	-------	13,002	10
Treatment 2: Set amount of seed and fertilizer per row						
16"	33,977	18,132	26,136	24,354	25,650	84
20"	29,664	17,250	21,693	20,182	22,197	59
24"	23,522	13,177	20,255	23,074	20,007	43
28'	23,896	13,068	17,735	15,144	17,461	25
32"	19,602	12,170	15,355	16,987	16,028	15
36"	20,328	12,124	15,827	15,803	16,020	15
40"	17,576	10,781	15,812	11,759	13,982	
Double rows		14,898	10,454	..	12,676	9.0

Table 3. Yield of Dekalb sorghum in row spacing test at State College, Mississippi.

Row space	1962	1963	1964	1965	Average	Percent increase over 40"
		Pounds of dry matter per acre				
Treatment 1: Set amount of seed and fertilizer per acre						
16"	18,459	20,255	16,988	10,184	16,472	69
20"	16,988	17,199	13,852	7,599	13,890	42
24"	18,186	15,899	11,761	7,062	13,277	35
28"	15,961	16,055	10,641	6,090	12,187	25
32"	14,456	12,496	9,801	5,118	10,468	7.0
36"	14,230	13,576	7,986	5,616	10,452	6.0
40"	12,153	13,656	8,625	4,654	9,772	-----
Double rows		18,557	7,187	-------	12,872	32
Treatment 2: Set amount of seed and fertilizer per row						
16"	24,829	21,889	17,315	9,585	18,404	85
20"	20,517	18,557	14,113	7,675	15,216	54
24"	17,860	16,988	11,326	7,789	14,491	37
28"	17,082	14,281	12,135	4,490	11,997	21
32"	17,723	12,088	8,821	4,029	10,665	8.0
36"	13,576	13,576	10,164	4,527	10,461	6.0
40"	15,028	13,460	7,710	4,343	9,885	....
Double rows		18,577	6,403	------	12,490	26

percent. This forage was the highest producer in the test so far as tons are concerned, but it would not be the best forage for many producers (because of its low grain to stover ratio.) It is least affected by the narrow row spacing of the forages in the test, with only 50 percent increase in yield resulting from reducing the row spacing from 40 inches to 16 inches.

In Treatment 2, 40-inch rows produced 13,982 lbs., and the 16-inch rows produced 25,650 lbs. an increase of 84 percent. Since FS-1A was the highest yielding forage in the test, this was the largest increase in the entire test.

Sorghum-Dekalb: Table III shows results with this crop. In Treatment 1 the

Table 4. Yield of corn (Pioneer) in row spacing test at State College, Mississippi.

Row space	1962	1963	1964	1965	Average	Percent increase over 40"
		Pounds of dry matter per acre				
Treatment 1: Set amount of seed and fertilizer per acre						
16"	3,104	12,088	13,068	14,770	10,758	80
20"	3,136	10,062	9,670	12,216	8,771	48
24"	3,267	11,108	9,148	10,783	8,576	44
28"	2,053	9,241	10,641	8,209	7,536	27
32"	2,450	9,066	7,024	6,311	6,213	5.0
36"	2,468	9,220	6,824	6,269	5,945	----
40"	2,483	8,494	6,795	5,997	5,942	----
Double rows		9,932	4,966	------	7,449	25
Treatment 2: Set amount of seed and fertilizer per row						
16"	3,757	12,905	15,028	15,270	11,740	95
20"	3,267	13,983	10,977	12,778	16,251	70
24"	3,267	11,761	8,712	10,297	8,509	41
28"	2,250	11,201	9,894	8,324	7,917	32
32"	2,777	10,699	7,514	7,004	6,998	16
36"	2,323	10,600	7,841	5,224	6,497	8.0
40"	2,287	8,364	7,449	6,027	6,032	----
Double rows		11,108	5,096	-------	8,102	34

increase in yield from 9,772 to 16,472 lbs. for the 40- to 16-inch spacing was 69 percent. The increase in yield from increased use of seed and fertilizer was less with silage sorghum than any other forage in the test. Since this is a large growing forage, water might cause such a limited difference.

In Treatment 2 the 40-inch rows produced 9,885 lbs., as compared to 18,404 lbs. for the 16-inch rows, or an increase of 85 percent. This is only 16 percent increase in forage for an increase of 50 percent in seed and fertilizer as compared to the 16-inch spacing in Treatment 1.

Corn-Pioneer; This forage (Table IV) produced only one crop per seeding in comparison of two crops for the other three forages. If corn is to be grown for silage, the plants per acre must be high, along with proper fertilization and water application. An increase in yield of 80 percent was obtained between 40- and 16-inch row spacings in Treatment 1.

There are two interesting results from treatment 2. One is the big increase of 34 percent of double rows. This is important because the present equipment will harvest this type of row spacing (two rows 7 inches apart on each bed) with 40-inch centers on beds. The other interesting factor concerns water and fertility. The 1962 results definitely point out lack of moisture, and the other three years' results point out that fertility without water will not produce corn for forage where the plant population is high The only difference in the double rows and 20-inch spacing on this treatment is the spacing, both receiving the same amount of seed and fertilizer. Yet, the 1964 yield was more than doubled on the 20-inch spacing.

Four Crops Compared: Summarized data presented in Table V is the average of four years' work of seven row spacings, using two treatments on four selected forage crops.

These data clearly show that narrow row spacing increases the yield per acre and permits the farmer to produce greater quantities of quality feed on fewer acres.

Results of row spacing studies using different rates of seeding and fertilization show that the yield of certain forages may be increased 63 percent by 16-inch row spacing instead of 40 inches. (Same seeding and fertilization rates per acre.) An additional 25 percent yield increase may be obtained with optimum seeding and fertilization.

The significant difference in yield of corn and the other forages may be observed in Table V. These data also show that the increase in yield as the row spacing is decreased forms almost a perfect regression curve.

It is generally agreed that corn is the best crop now available for forage or silage. However, due to soils and weather, some areas cannot produce a satisfactory corn crop every year without supplemental water. Therefore, other crops such as grain sorghum, sweet sorghums, and sorghum-sudan hybrids are grown in many areas of the South for forage, the reason being that these crops will produce more forage with less water. They have the ability to withstand the short droughts and make a quick recovery.

This is the main reason that corn is not used more extensively for silage. Attention is invited to Table IV for a look at the spread in yield for the four years. One does not have to go to the weather records to know that 1962 was very dry at a critical time for the growth of corn. The increase in yield of the four forages (Table V) was affected more by row spacing than any other factor. The type of forage had little or no effect.

To obtain the desired results with a forage program, a particular forage or forages must be selected that will meet the needs of a producer. The dairy and beef producers both want a quality forage but may not need the same grain-stover ratio. Generally, the stage of maturity of the forage may determine to a large extent the quality. In planning a forage program, the planting dates should be scheduled so that any one planting can be harvested within a period of one week Sometimes two varieties of forage with different number of days to maturity will solve this problem.

Other research work concerning row spacing, seeding rates, and varieties of forages conducted by the Agronomy Department of Mississippi State University show results similar to those given in this report.

The close row spacing presents a machinery problem in production and harvesting of forage for silage. This is the area in which we hope to adapt, design and construct some equipment in order that the farmer may take full advantage of these important yield increases.

Table 5. Comparison of forage yields, in dry matter per acre, for four crops used in row spacing study, 4-year averages.

Row spacing	Corn	RS-610	FS-1A	Dekalb-50A	Average	Percent increase over 40"
		Pounds of dry matter per acre				
Treatment 1: Set amount of seed and fertilizer per acre.						
16"	10,728	15,402	21,555	16,472	16,039	63
20"	8,771	13,614	20,073	13,890	14,087	44
24"	8,576	12,349	20,008	13,227	13,540	38
28"	7,536	11,697	16,366	12,187	11,946	23
32"	6,213	9,768	15,271	10,468	10,630	8.0
36"	5,945	9,362	15,399	10,352	10,264	5.0
40"	5,942	9,094	14,394	9,772	9,800	—
Treatment 2: Set amount of seed and fertilizer per row.						
16"	11,740	17,789	25,650	18,404	18,395	88
20"	10,251	14,831	22,197	15,216	15,623	60
24"	8,509	12,094	20,007	13,491	13,728	41
28"	7,985	12,149	17,461	12,110	12,426	27
32"	6,998	10,053	16,028	10,665	10,936	12
36"	6,497	9,542	16,020	10,461	10,630	9.0
40"	6,032	9,156	13,982	9,885	9,763	—

BULLETIN 726 MAY 1966

Cost Study In Producing Milk For Manufacturing Purposes

BY B. C. HURT, JR. AND
MASON SUMRALL

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Cows on summer grazing at the Pontotoc station.

COST STUDY IN PRODUCING MILK FOR MANUFACTURING PURPOSES

BY B. C. HURT, JR. AND MASON SUMRALL

There is a strong demand for milk for manufacturing purposes, but is the price received for this milk enough to justify the investment under the present economical conditions? This is the question raised by farmers today.

In 1957 there were 15,743 producers in Mississippi and by the end of 1962, the number had decreased 46.0 percent to 8,500. Production per farm has been increasing, but at a rate too slow to maintain supplies.

To attempt to answer some of these questions a controlled cost study was made at the Pontotoc Branch Experiment Station using a herd of grade Jersey and Holstein cows.

The original animals were purchased as heifers in 1955 and bred artificially during the entire period of the study. The sires used were the ones available to the northeast area of Mississippi.

When the study had begun in 1959, the herd consisted of 42 two-year-old heifers and mature cows that averaged 8,600 pounds of 4.2 percent butter fat milk per cow.

For the five-year period there was an attempt to maintain about equal numbers of Holstein and Jerseys, with a total of 40 milking cows. Some years the cow numbers dropped below 40; the average number during the five years was 38.6 cows.

The cows were milked by one man in a parlor type barn with two elevated stalls on each side of the center aisle. Four cows entered the parlor at a time, and with a two-unit machine, two were milked while two were being prepared. The milk went into calibrated jars, and after the weight was recorded it was conducted through a glass pipeline to cans in an adjoining milk room. A covered concrete pen is connected to the milk parlor to hold the cows prior to milking.

A pole type shed was used for feeding hay and silage. The hay was stored in a barn, and the silage in a 175-ton capacity concrete trench silo.

Pasture Program

The permanent and temporary pastures consist of approximately 70 acres located in the flatwoods soil area. Pasture practices decribed here conform to current recommendations. Permanent pastures, composed of Dallisgrass and white clover, were utilized from late winter through the summer months. The permanent pastures were established from wooded areas in 1954. Two tons of lime were applied to these pastures at five-year intervals. An annual application of 60 pounds of phosphorus and 60 pounds of available potash was applied There was an excellent grass-clover combination for the first three years, however, with sub-zero weather in the winter of 1963, the clovers were reduced to about a 10% stand. Clover seed was applied in the spring of 1963 and stands were increased to 40% the last two years. During the entire test period Dallis stands were excellent and growth was considered adequate. Under ideal growing conditions these pastures provided enough forage for two cows per acre However, through much of the summer after June 20 one acre would supply forage for only one cow. In dry periods the permanent pasture had to be supplemented with temporary grazing crops as millet.

Each year one-half acre of Starr millet per cow was planted in mid-May to supplement the permanent pastures. The millet was seeded at the rate of 20 pounds per acre and fertilized with 33 pounds of nitrogen and 40 pounds available phosphorus and potash at planting time. After the millet was well established an additional 33 pounds of nitrogen was applied.

The millet provided controlled grazing from the last of June until late August when the land was prepared for oat planting.

By the first of September, the area planted to millet was prepared for oat seeding. A recommended oat variety was sowed at the rate of 4 bushels per acre. The oats were fertilized with 50 pounds of available nitrogen, 60 pounds of available phosphorus and potash each at the time of planting. The oats were top-dressed with 33 pounds of available nitrogen in December and March if sufficient growth was made for fall grazing. The oats were generally large enough for grazing the last of October and provided controlled grazing through December. Most winters, cattle were removed from oat forage after January 1 until the last of February. Throughout the winter grazing period, the time the cows grazed oats each day depended on the amount of forage available. Hay was fed the entire winter period, but silage was fed only when grazing was limited or not available.

Silage

Oats cut in the spring and millet cut in the summer were ensiled for feeding the dairy herd during the winter months. Both of these plants produced a good quality silage. This type silage constituted the larger part of the ration for yearling heifers and dry cows.

Hay Feeding

Alfalfa was the principle hay fed to the milking herd while oat and lespedeza hay was substituted when alfalfa supplies were scarce. Hay was fed free choice throughout the winter, even when cows were on part time grazing. About two pounds of hay per 100 pounds of liveweight was consumed. Good quality hay helped maintain a high level of milk production when pastures did not provide adequate forage.

Calves are raised in portable pens.

Concentrate Feeding

Concentrates, composed primarily of .home grown grains, were fed at the rate of one pound of grain for each three pounds of milk produced. Cottonseed meal or soybean meal, as the chief protein source, was added to corn and oats to provide a 13 percent protein feed. Five percent molasses and 1 percent salt were added to the above mixture.

Raising Replacement Heifers

Since 1955, the Pontotoc Branch Station has been raising calves in portable pens. Over 150 heifers have been raised with no deaths or serious disease trouble. Success has been attributed to the use of 5' x 10' portable pens and the management practices followed.

At calving time the cows are kept outside in an area of pasture which is considered not to be heavily contaminated with disease producing organisms. After birth, the calves remain with their dams for at least 24 hours. Then the calf is placed in a portable pen. Oat straw or some other good bedding is kept in the pen at all times. Since colostrum milk is necessary for raising good healthy calves, the dam's milk is fed for several days. Milk is fed twice daily in a nipple pail, and one pail is provided for each calf. The amount of milk fed is about 1 pound for each 10 pounds of body weight. This is increased with growth but never exceeds 12 pounds per day.

In addition to milk, the calves are fed a commercial calf starter, legume hay, salt and fresh water. Each calf has its own water pail, feed pail and hay rack. The calves begin eating the starter at 7-10 days of age. It is fed free choice and when a calf starts eating 2 to 2 ½ pounds of the commercial starter, the milk may be reduced or stopped completely at this stage without any ill effect. At two months of age the concentrate fed to the milking herd is added to the starter and at three months the commercial starter is left out. At five months, calves are vaccinated for brucellosis and blackleg and put in pasture with other calves. They are dehorned at an early age by using a paste or plastic dehorning compound.

The portable pens are placed 7 feet apart in a line at the lower end of the area to be used for raising calves. Once each week the pens are moved to fresh ground and new bedding is put in. They are moved uphill on a zig-zag course so as to utilize all ground area possible.

The pens are inexpensive and easy to build. The primary materials used are lumber (1" x 4"), net wire and an aluminum top for part of the pen. The roofing is needed for protection from rain, cold, or heat. Protection from wind on the north and west sides of the pen is furnished by plastic or some light-weight material. The pen can be easily disassembled when not in use.

The success of this system of raising calves can be attributed mainly to sanitation in feeding and the weekly movement of pens to clean ground.

Management of Older Heifers

When the calves are taken out of the portable pens, they are kept in groups away from larger and older animals. Pasture provides the feed for these heifers and is supplemented with grain when the quality goes down in the late summer. As soon as winter grazing is available the heifers obtain the needed nutrients from this source.

In late winter, it is usually necessary to remove the heifers from the cereal crops. When this is done they are put into a lot with shelter and fed silage, hay and a concentrate of crushed corn cob and shuck meal and a protein meal. This grazing and feeding program is followed until the heifers are put into the milking herd. The thrifty heifers are bred to calve at the age of two years, unless this results in the calf dropped at an undesirable time. Others are bred according to their growth and development.

Dry Cows

Pasture provides the major portion of the feed fed to dry cows. As long as good lush pastures are available dry cows will obtain their needed nutrients. When the quality of the pasture drops, the dry cows are fed a concentrate of crushed ear corn and protein meal. When grazing is not available, the dry cows are fed a ration of silage, hay and a concentrate of crushed ear corn and protein meal. The concentrate ration is usually mixed in a ration of 100 pounds of protein meal to 600 pounds of corn and fed in varying amounts according to roughage available.

Financial Summary

During the five-year period analyzed, June 1, 1959—May 31, 1964 the herd averaged 38.6 cows two years old and older. Each year some cows were culled and young cows raised on the Station were added to the herd. Each year the

Table 1. Annual returns to labor and capital for dairy operations at manufactured milk prices, Pontotoc Branch Experiment Station.

Item	Average cost and return for 1959-1964 period		
	Herd	Per cow	Per 100 lb. milk
Feed Cost:[1]			
Concentrates	$ 4,231	$110	$1.15
Hay	1,367	35	.37
Silage	868	22	.23
Total	$ 6,466	$167	$1.75
Pasture Cost:			
Fertilizer	$ 901	$ 23	$ .24
Seed	206	5	.05
Land preparation, seeding, applying fertilizer and mowing	724	19	.20
Total	$ 1,831	$ 47	$ .49
Other:			
Hauling and ADA	$ 1,511	$ 39	$ .41
Veterinary and breeding	711	18	.19
D.H.I.A.	263	7	.07
Miscellaneous	483	13	.14
Total	$ 2,968	$ 77	$ .81
Total cost:[2]	$11,265	$291	$3.05
Less cattle sales	2,788	72	.75
Less increase in inventory[3]	550	14	.15
Cost of producing milk	$ 7,927	$205	$2.15
Value of milk produced	$12,915	$334	$3.50
Return to labor and capital	$ 4,988	$129	$1.35
Average milk production annually	371,963	9,636	
Percent butterfat	4.1		
Average cows milked	38.6		
Average price for 4.1% B.F. milk	$3.50		

[1] Feed charged at market prices.

[2] Does not include a charge for the following: (1) labor, (2) interest on investment in land, cattle, buildings, equipment and fencing, and (3) depreciation on buildings, equipment and fencing.

[3] Cows were valued at $225, 2-year-old heifers at $175, 1-2 year-old heifers at $125, and heifer calves at $75.

cows in the herd varied, therefore, the average number milked during this period also varied.

In calculating feed cost, concentrates and hay were charged at the average prices paid by Mississippi farmers. Silage was charged to the dairy enterprise at approximately one-third of the cost of hay.

Pasture costs were calculated as follows: Seed and fertilizer were charged at the average prices paid by Mississippi farmers. Land preparation, seeding, applying fertilizer and mowing were charged at the usual custom rates. Pasture cost was reduced by the value of roughage harvested from the pasture acreage less the cost of harvesting.

Other costs were those paid by the Station for supplies and services used in the dairy operation.

The annual total cost amounted to $11,265 for the herd and $291 per cow. Feed and pastures were the most important items of cost. Concentrates accounted for 37.5 percent of total cost, roughage for 20 percent, and pastures 16 percent. The cost of producing milk was calculated by deducting the value of the cattle sold and increases in the cattle inventory from total herd cost. The annual cost of producing milk averaged $205 per cow and $2.15 per hundred pounds of milk.

The annual milk production amounted to 371,963 pounds of 4.1 percent butter fat milk for the herd and 9,636 pounds per cow. The annual value of milk produced amounted to $12,915 for the herd, $334 per cow and $3.50 per 100 pounds.

Several factors other than milk production aided in return to labor and capital. Yearly cattle sales amounted to $2,788 and the inventory was increased$550 annually. This decreased the cost of producing milk by 30 percent. The returns to labor and capital averaged $4,988 for the herd, $129 per cow and $1.35 per 100 pounds of milk.

APPENDIX

These costs and returns figures for a typical 30-cow herd were prepared by James G. Hamill and Verner G. Hurt, Experiment Station economists, to provide additional guidance for producers of milk for manufacturing purposes. They do not pertain to the Pontotoc herd.

Appendix Table 1. Manufacturing Milk: Estimated costs and returns per 30 cows, advanced technology (9500 pounds per cow—3.6% B.F.)

Item	Unit	Quantity	Price	Amount
Income				
Milk	cwt.	2,850.00	$3.25	$ 9,262.50
Livestock sales				1,128.00
Total				$10,390.50
Expenses				
Cottonseed meal	cwt.	232.50	4.10	954.48
Salt	cwt.	9.31	2.00	18.62
Deflourinated phosphate	cwt.	9.31	3.33	31.00
Corn (ear corn)	cwt.	698.49	1.67	1,166.48
Grinding and mixing	cwt.	949.91	.30	284.97
Silage (375 ton—custom harvest)	acres	25.00	57.46	1,436.50
Pasture (permanent)	acres	21.00	16.33	342.93
Pasture (temporary summer)	acres	30.00	21.20	636.00
Breeding and testing	herd			362.10
Hauling	cwt.	2,850.00	.20	570.00
Miscellaneous	cow	30.00	14.36	430.80
Total				$ 6,233.88
Net returns over specified expenses				$ 4,156.62
Less depreciation				2,786.00
Returns to land, labor, capital and management				$ 1,370.62
Less 5% interest on average investment ($26,814)				1,340.70
Returns to labor and management				$ 29.92

Appendix Table 2. Estimated investment and depreciation for producing manufacturing milk per 30 cows, advanced technology.

Item	Number	Cost	Estimated life in years	Annual depreciation
Land (acres in crops and pastures)	76	$11,400		----
Barn and milk parlor	1	3,100	20	$155
Pipe line milker	1	1,200	12	100
Milk cleaning equipment	1	300	10	30
Bulk tank (400 gal.)	1	2,000	15	134
Silo (20 x 50)	1	3,890	25	156
Blower (silage)	1	800	5	160
Automatic feeding (including troughs)	1	1,917	10	192
Fence (3 miles @ $640)		1,920	20	96
Deep well	1	1,000	10	100
Hot water heater	1	60	5	12
Tractor (2-row)	1	3,000	10	300
Disc harrow	1	1,000	10	100
Harrow (2 section)	1	100	20	5
Planter (2 row w/fert. attach.)	1	380	20	19
Cultivator (2-row)	1	240	12	20
Fertilizer distributor (10')	1	320	10	32
Mower (5')	1	600	12	50
Livestock (30 cows @ $300)		9,000	4	1,125
Total		$42,227		$2,786

Some points needing emphasis:

1. Custom harvest of silage must be available (possibly organized by the plant) if acreage is limited.
2. Bulk handling of milk is more economical, thus the necessity for a bulk tank.
3. Silage must be depended on as an annual feed as much as possible.
4. The additional investment will vary depending upon each individual farm.
5. Production level shown in appendix tables must be considered a minimum.
6. Financing should be accomplished mainly on the basis of the expected average life of each item.
7. Depreciation must be considered for those items which will be used up in the production process.
8. Interest on investment is particularly relevant for the present and additional investment financed by borrowing.

BULLETIN 727 JULY 1966

Incidence Of Parasitic Insects On The Bollworm In Mississippi

By W. J. LEWIS and J. R. BRAZZEL

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Conclusions

Significant natural control of the bollworm was derived from parasitic insects on all host plants except corn. The parasites provided a very high percent of control on cranesbill, tomato, and spiderflower. Parasitism of bollworm on crimson clover was low in the 1964 season but became more significant in the 1965 season. Parasitism of bollworms on cotton varied in different fields and at various times in the season. Parasites were, however, an important economic factor on this crop and can be of increased importance when properly utilized under a carefully applied integrated control program.

INCIDENCE OF PARASITIC INSECTS OF THE BOLLWORM IN MISSISSIPPI

By W. J. LEWIS and J. R. BRAZZEL

In recent years the two species of bollworm—the tobacco budworm[1] and the cotton bollworm[2]—have increased in importance as pests of cotton in the Southeastern United States. Insecticide resistance in these pests and the growing concern over residue problems have emphasized the need for additional means to aid in control of the bollworm and other cotton pests and minimize the use of insecticides.

In Mississippi many are finding a properly applied biological control program for cotton pests to be efficient and economical. Such a program necessitates a good understanding of the many factors that affect the abundance of the cotton pests.

A study was undertaken during the 1964 and 1965 seasons to determine what parasitic insects attack bollworm larvae in Mississippi and how much natural control is obtained from these parasites. Bollworm larvae were collected from cotton and major alternate host plants throughout Mississippi. The collected larvae were placed in vials on artificial diet, brought to the laboratory and identified as to the species of bollworm, and then held in the laboratory to determine how many were parasitized and by what kind of parasites.

A bollworm which was parasitized would eventually succumb to the parasite and the fully developed larval stage of the parasite would eat its way from the bollworm. These parasite larvae were reared to the adult stage and identified as to the kind of parasite.

The following information was recorded for each species of the bollworm: host plant from which they were collected, location of host plant, date collected, number parasitized, kind of parasites, and number of bollworms that died from causes other than parasitic insects (disease, injury, etc.). The percent of each of these collections of larvae dying from parasitism was calculated from these data.

The percent parasitism was calculated from a corrected total obtained by subtracting those that died from causes other than parasitic insects. These larvae were subtracted because surely they included some parasitized larvae. These data indicate the amount of natural control that was being derived on these dates by parasitic insects alone. Control by predaceous insects and other means are not represented in these figures.

Findings for each of the host plants will be discussed separately. Also results for each species of bollworm are presented separately. Throughout both seasons, the most commonly occurring parasites were two small wasps, **Microplitis croceipes** (Cress.) and **Cardiochiles nigriceps** Vierick. Interestingly the latter species has been found to successfully parasitize only the tobacco budworm.

Parasitism on Alternate Hosts (Table 1)

Parasitism of bollworms collected from crimson clover in 1964 was low. The larvae were collected during the latter part of April and early May and were at a ratio of about 5 cotton bollworms to 1 tobacco budworm. None of the tobacco budworms were parasitized. Parasitism of the cotton bollworms averaged about 10%.

Collections were made from crimson clover on April 28 and May 4 in the 1965 season. One unparasitized tobacco budworm was collected on May 4. All the other collected larvae were the cotton bollworm. Of the total 156 cotton bollworms collected, 25% were parasitized.

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[1] Heliothis virescens (F.)

[2] Heliothis zea (Boddie)

Table 1. Parasitism of bollworms on the indicated major alternate host plants.

Date collected	Number larvae collected	Dead: Disease and injury	Corrected total larvae	Number parasitized	Number pupated	Percent parasitism
From Crimson Clover						
1964			Cotton bollworms			
4/24	6	2	4	0	4	0.0
4/29	16	3	13	1	12	7.9
5/5	69	35	34	3	31	8.8
5/11	8	4	4	1	3	25.0
5/14	2	1	1	0	1	0.0
1964			Tobacco budworms			
4/29	1	0	1	0	1	0.0
5/5	11	1	10	0	10	0.0
5/11	3	1	2	0	2	0.0
5/14	3	2	1	0	1	0.0
1965			Cotton bollworms			
4/28	82	2	80	20	60	25.0
5/4	74	6	68	17	51	25.0
From Cranesbill						
1964			Cotton bollworms			
4/29	4	1	3	3	0	100.0
5/11	8	4	4	4	0	100.0
5/13	12	4	8	4	4	50.0
5/18	7	0	7	7	0	100.0
1965			Tobacco budworms			
5/11	5	4	1	1	0	100.0
5/14	23	12	11	9	2	81.8
5/18	11	2	9	7	2	77.7
5/28	8	7	1	1	0	100.0
1965			Cotton bollworms			
4/28	4	0	4	0	4	0.0
5/4	14	0	14	9	5	64.2
5/13	22	10	12	2	10	9.1
From Tomato						
1964			Cotton bollworms			
5/22	14	3	11	7	4	63.6
6/2	14	0	14	12	2	85.7
From Spider Flower						
1964			Tobacco budworms			
6/20	47	25	22	17	5	84.6
6/25	11	0	11	11	0	100.0

Bollworm larvae were collected from cranesbill in 1964 during the latter part of April and during May. The tobacco budworm and cotton bollworm larvae were collected in about equal numbers. The parasitism on both of the species ranged from 50 to 100%.

In 1965 bollworm larvae were collected from cranesbill on April 28, May 4, and May 13. The majority of these larvae were the cotton bollworm. One unparasitized tobacco budworm was collected on April 28. Two tobacco budworms were collected on May 13. One of these larvae succumbed to a parasite. Parasitism of the cotton bollworm ran from 0% on April 28 to 64.2% on May 4 and dropped back to 9.1% on May 13.

Extensive collections were made from corn throughout the 1964 season. All of the larvae collected were the cotton bollworm (or corn earworm) as the tobacco budworm does not attack corn in the United States. Parasitic insects of the bollworm larvae on corn were found to be of little importance as parasitized larvae were very rarely found. This is probably due to the fact that the larvae are well protected from parasitic insects due to their feeding habits on corn.

Two collections were made from tomato in the 1964 season. All the collected larvae were the cotton bollworm (or tomato fruitworm). Fourteen larvae were collected on May 22 and 14 were collected on June 2. A high percentage of the larvae in both collections were parasitized, 63.6% and 85.7%, respectively.

Bollworm larvae were collected from spiderflower (an ornamental) on June 20 and 25 of the 1964 season. All of them were the tobacco budworm. The larvae of the two collections were heavily parasitized, 84.6% and 100%, respectively.

The high percent of parasitism of bollworms attacking cranesbill, tomato, and spider flower could have a profound bearing on the importance of these host plants in the build-up of bollworm and parasite populations in early season.

Parasitism of Bollworms on Cotton (Table 2)

Bollworm larvae were collected from cotton from late May until November of the 1964 season. The data presented in the tables consist of recordings from many scattered places throughout the Delta and North Hills area of Mississippi. The percentages of parasitism varied throughout the season on both species of bollworm. However, the data show that parasitic insects were an important natural control on cotton. The percentages of parasitism were often in the range from 30 to 60 percent. The percentages were steadily higher on the tobacco budworm than on the cotton bollworm.

During the 1965 season bollworm larvae were collected from cotton from early June until early September. The collections were not as extensive and regular as those in the 1964 season but were made in the same areas. Parasitism was low on the cotton bollworm in early season. However, the tobacco budworm was of higher incidence at this time and the parasitism was rather high on this species. As the season progressed the parasitism held steadily above 20% on the tobacco budworm and became increasingly important on the cotton bollworm.

In the 1964 season, records for larvae collected from cotton that had not been treated with insecticides were kept separate from those of larvae found on untreated cotton. In general the parasitism of larvae from the untreated cotton was several times as high as that of larvae collected from treated cotton (Table 3). This comparison holds true in all three cases, (Greenwood and Rolling Fork for the cotton bollworm and the Greenwood area for the tobacco budworm) where the larvae were collected from treated and untreated cotton in the same area. The cotton bollworms collected from Holly Springs and the tobacco budworms collected from Wayside and Holly Springs (only 8 larvae) were the only larvae from treated fields with a percent parasitism comparable to that of the larvae from untreated fields.

Parasites seemed to be relatively abundant in the earlier part of the cotton season. This appeared especially clear in the 1964 June and July larval collections (Table 2.) These parasitized larvae probably represented adult parasites that had moved in from alternate early season host plants where they had become established in April and May. These early season adult parasites in the cotton are probably a very crucial part of the parasite population and need to be protected so as to allow the parasite population to become well established in the cotton field.

Table 2. Parasitism of the bollworms collected from cotton.

Date collected	Number larvae collected	Dead: Disease and injury	Corrected total larvae	Number parasitized	Number pupated	Percent parasitism
1964		Tobacco budworm				
6/24	56	32	24	10	14	41.7
6/29	39	18	21	7	14	33.3
7/1	97	43	54	28	26	51.9
7/17	2	1	1	1	0	100.0
7/24	39	15	24	6	18	25.0
7/28	71	46	25	8	17	32.0
8/4	51	18	33	6	27	18.2
8/19	20	7	13	4	9	30.8
8/26	70	19	51	11	40	21.6
9/2	184	37	147	24	123	16.3
9/8	139	54	85	6	79	7.1
9/16	45	28	17	0	17	0.0
9/26	66	21	45	20	25	44.4
10/7	13	3	10	3	7	30.0
10/12	11	10	1	1	0	100.0
10/23	1	0	1	1	0	100.0
11/10	8	3	5	2	3	66.6
11/16	8	5	3	1	2	33.3
1964		Cotton bollworm				
5/26	8	1	7	2	5	28.6
6/2	5	2	3	1	2	33.3
6/16	10	4	6	1	5	16.6
6/24	8	1	7	1	6	14.3
6/29	45	7	38	6	38	13.5
7/1	101	26	75	12	63	16.0
7/24	25	4	21	5	16	22.7
7/28	62	37	25	9	16	36.0
8/4	15	0	15	0	15	0.0
8/12	22	3	19	6	13	21.6
8/19	33	4	29	2	27	6.9
8/26	172	25	147	15	132	10.2
9/1	129	48	81	15	66	18.5
9/8	87	36	51	2	49	3.9
9/16	22	11	11	0	11	0.0
9/27	249	74	175	11	164	6.3
10/7	21	11	10	0	10	0.0
11/10	87	19	68	11	57	16.2
11/12	78	54	24	9	15	37.5
11/16	215	107	108	51	57	47.2
1965		Tobacco budworm				
6/11	9	0	9	0	9	0.0
6/18	3	0	3	0	3	0.0
6/23	175	57	118	24	94	20.3
6/30	15	8	7	5	2	71.4
7/22	5	1	4	0	4	0.0
7/29	4	0	4	1	3	25.0
8/18	26	1	25	6	19	24.0
8/25	81	9	72	23	49	31.9
9/4	136	18	111	18	93	16.2
9/8	24	1	23	11	12	47.8
1965		Cotton bollworm				
6/11	8	0	8	0	8	0.0
6/18	0	0	2	0	2	0.0
6/23	84	20	64	4	60	6.3
6/30	5	3	2	0	2	0.0
7/22	5	1	4	0	4	0.0
7/29	11	1	10	0	10	0.0
8/18	87	5	82	7	75	8.5
8/25	186	7	182	23	159	12.7
9/4	74	13	61	7	54	11.5
9/8	36	6	30	8	22	26.6

Table 3. Parasitism of bollworms collected from cotton in insecticide treated and untreated fields.

Location	Dates	Corrected total larvae	Number parasitized	Percent parasitism
		Cotton bollworms		
Greenwood				
(treated)	8/2 - 9/26	90	3	7.3
(untreated)	7/4 - 9/2	88	24	27.3
Rolling Fork				
(treated)	7/28 - 8/26	63	6	9.5
(untreated)	5/26 - 6/24	14	3	21.4
Yazoo City				
(treated)	8/8 - 9/27	123	6	4.9
Tutwiler				
(treated)	8/19 - 9/8	56	5	8.9
Wayside				
(treated)	6/24 - 7/28	137	22	16.0
Holly Springs				
(treated)	7/30 - 9/2	29	8	27.6
		Tobacco budworms		
Greenwood				
(treated)	8/4 - 9/26	93	17	18.3
(untreated)	6/24 - 9/2	95	40	42.1
Yazoo City				
(treated)	8/4 - 9/27	110	14	12.7
Tutwiler				
(treated)	8/19 - 9/8	116	17	14.7
Wayside				
(treated)	6/24 - 7/28	76	30	39.5
Holly Springs				
(treated)	7/23	8	4	50.0

BULLETIN 728 JULY 1966

Organic Mulches Improve Strawberry Plant Growth

By J. P. OVERCASH

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Summary

An experiment was conducted to determine the feasibility of permanent mulches for strawberry plants managed by the hill system of culture. Virus-free plants of the Pocahontas variety were used in single rows 36 inches apart with three rows each 20 feet long constituting a plot and records were made only from the center row. Clean cultivation was compared with black plastic, pine straw and sawdust mulches.

1. Plant survival after two years was about twice as good under the organic mulches as for clean cultivation or black plastic mulch. The strawberry plant vigor of surviving plants was much better under organic mulch culture.

2. Yields of berries were about twice as great from plants grown with pine straw or sawdust mulches as for black plastic mulch or clean cultivation.

3. Soil moisture was higher under mulched plots at both 0 to 6 and 6 to 12 inch soil depth than under clean cultivation.

4. Soil temperatures between plants were much higher for clean cultivation and black plastic plots. Even at 6 inches deep in the soil the temperatures were about 10 degrees F. warmer for those plots than for plots mulched with pine straw or sawdust.

5. Plant vigor throughout the experiment was better for organic mulched plots as measured by numbers of leaves and weight and number of runners formed than for clean cultivation and black plastic plots.

ORGANIC MULCHES IMPROVE STRAWBERRY PLANT GROWTH

By J. P. OVERCASH

Strawberries are grown in all the states from Florida to Alaska. They have a wide range of climatic adaptation, even though the fruits ripen and develop their best quality during the cool weather in early spring. In south Mississippi, Florida, Louisiana and the other states bordering the Gulf of Mexico, strawberry plants are grown by the hill system during the winter for fruit production in late winter and early spring. The plants are not carried in the fields during the hot dry summers. The warm winters permit sufficient vegetative growth from plants set in the fall to produce fruit in late winter or early in the spring.

In south Mississippi the strawberries which are grown in the Gulf Coast Area are grown by the hill system, therefore, summer heat and droughts are not a problem. In the central and northern areas of the state, strawberries are managed in the matted row system. Plants are set in rows 3½ to 4 feet apart in the field in late winter or early spring. The plants are spaced 18-24 inches apart in the row. Under favorable weather conditions these plants produce runners which make new plants by rooting when soil moisture and temperatures are suitable and thus matted rows of plants are formed. The matted rows may range from 18 to 30 inches in width at the end of a favorable summer.

When adverse weather conditions prevail, the new runner plants either fail to form or do not develop roots. This results in poor stands of plants in the matted row and subsequent poor yields. Soil as well as air temperatures are often too high for favorable strawberry plant growth for prolonged periods of time during the summers in Mississippi. The most favorable temperature for many varieties of strawberry plants appears to be about 75 degrees F. and as the temperatures rise above this point, the plants grow less.

The studies reported here were conducted to determine the feasibility of using permanent mulches on the soil around the plants on a year round basis for strawberries. The influence of three mulches on plant growth, runner formation, soil moisture and temperatures was studied. Yield and plant survival with various mulch treatments were observed.

Materials and Methods

Three mulching materials were selected for use in these tests. One synthetic material was used, a black polyethylene plastic film of 6 mil thickness. This thickness was selected because of its durability. It lasted two years in the field with very little breakdown. Two organic mulches of local origin were selected because of their availability, freedom from weed seed and durability. One application each of pine straw and sawdust (hardwood) was made and lasted for two years with no replacement.

A site was selected with a sandy loam soil. The slope was about five percent and the water drained in two directions. The soil was prepared by plowing, disking and bedding the rows, which were 36 apart, to a height of about 10 inches. They were then leveled to about five inches of height. When the soil was prepared, two and one half pounds of 8-8-8 fertilizer was applied per 20 feet in the row and mixed with the soil before bedding. This was at the rate of about 1,800 pounds per acre. Dieldrin was included with the fertilizer at the rate of 2 pounds actual per acre for the control of soil borne insects which feed on strawberry roots.

In order to reduce the possibility of root knot nematodes and root rot diseases, as well as to control early spring weeds, the rows were treated with a preplant soil fumigant, sodium m-methyl dithio carbamate, which was applied as a Vapam formulation. This fumigant was applied at the rate of 1 quart in two gallons of water sprinkled 18 inches wide on each 100 feet of row on March 23, 1961. The soil was immediately rebedded on top of the treated area.

Nineteen days after the Vapam soil treatment, the beds were flattened to a settled height of about 6 inches. The plots were then laid out and set with virus-free plants of the Pocahontas variety obtained from a commercial nursery. Alleys, 5 feet wide, were left between replicates. Water drainage from each replicate was arranged so that each alley served as a drain and water from each plot ran into the alley.

The four treatments (check, black plastic, pine straw, and sawdust) were arranged in a 4x4 latin square. Each plot consisted of three rows, 20 feet long and the plants were spaced 12 inches apart in the row. All records were made on the center row in order to minimize border effects between plots.

Two months after the plants were set in the plots, they were cultivated to remove weeds and to thoroughly pulverize the soil before the mulches were applied. The black plastic film was stretched over each of four plots and slits cut to pull the plants through. Holes were then punched in the film between the plant rows to permit rainfall penetration. The holes were ¼ inch in diameter and spaced about 6 inches apart.

For the organic mulch plots, pine straw and sawdust were applied around the plants and in the middles between rows to a uniform depth of about 3 inches. After settling, these materials remained about 2 inches deep throughout the remainder of the first season. All mulches remained effective through the second summer.

Temperature data were recorded once each season on the soil or mulch surface in the sun between plants, in the shade of plants and at three depths in the soil between plants, by the use of soil thermometers which had been checked for accuracy with a mercury thermometer. Soil moisture was determined by collecting samples from 0 to 6 inch and 6 to 12 inch depths by using a soil auger. These samples were placed in small cans and weighed, then oven dried at 220 degrees F. for 48 hours, then reweighed and their percentage moisture calculated on a dry weight basis.

Vegetative growth was recorded by counting the leaves per plant and the runners formed. Leaves were counted monthly the first season and once in mid-summer of the second season. Runners were removed monthly and the number as well as total weights of runners removed per row were recorded. Yields were recorded in pounds of fruit per row. The number of live plants per plot was recorded throughout the experiment as a measure of plant survival.

Results

The influence of mulch treatments on leaf formation and retention is shown in Table 1. At the end of the first summer the plants in the mulched plots had more leaves than plants in the check plots under clean cultivation. These differences were accentuated by mid-summer of the second year. There were more than twice as many leaves per plant in the pine straw plots than in the clean cultivated plots. Furthermore, the leaves were much larger and healthier as shown in Figure 1.

Runner formation was influenced by the mulch treatments. Only minor differences in numbers of runners existed at the end of the first season, however, significant differences in weights of runners were recorded, Table 2. Runners produced by plants with pine straw or sawdust mulches were larger and heavier than runners from plants in check or plastic mulch plots.

Table 1. The influence of permanent mulches on the number of leaves per plant of the Pocahontas strawberry.

	First Summer				Second Summer
Soil Treatment	July 15	Aug. 15	Sept. 15	Ave.	July 2
Check	17.9	16.3	16.4	16.9	17.3
Black Plastic	19.8	19.3	19.5	19.5	19.4
Pine Straw	18.6	22.5	22.2	21.1	42.2
Sawdust	19.1	20.8	19.7	19.9	28.2
L.S.D. Treatment means		.05		3.1	6.0
		.01		4.7	9.1

Table 2. The influence of permanent mulches on runner formation by Pocahontas strawberry plants during their first summer in the field.

Date runners removed	Check	Black Plastic	Pine Straw	Sawdust	Total
		Number of runners removed per plant			
July 15	7.4	8.0	7.3	7.7	30.4
August 15	8.8	8.0	11.3	10.9	39.0
September 15	1.6	.3	2.0	1.1	5.0
Totals	17.8	16.3	20.6	19.7	74.4
L. S. D. Treatment means for season totals		.05 — 2.6, .01 — 3.9			
		Weight (grams) of runners removed per plant			
July 15	36.8	33.9	35.4	46.9	153.0
August 15	28.2	26.1	67.0	45.3	163.6
September 15	2.6	.7	8.4	4.6	16.3
Totals	67.6	60.7	107.8	96.8	332.9
L.S.D. Treatment means for season totals		.05 — 21.7, .01 — 32.9			

Table 3. The influence of permanent mulches for strawberry plants on average soil temperatures in degrees Fahrenheit.*

Place temperature recorded	Check	Black Plastic	Pine Straw	Saw-dust	Aver-age	L. S. D. for Treatment Means	
			Degrees F.			.05	.01
Soil or Mulch surface in sun	116	118	113	116	116	8.0	12.1
Soil or Mulch surface in shade	105	102	99	99	101	4.7	7.1
1" deep between plants	103	98	85	89	94	3.4	5.2
3" deep between plants	94	96	84	85	90	3.6	5.4
6" deep between plants	90	91	79	83	86	4.7	7.2
Average	102	101	92	94			

*Average temperature at two PM for two dates: Sept. 22, 1961 and July 9, 1962.

Variations in plant performance may be partly explained by the temperature data shown in Table 3. The temperatures recorded for the soil or mulch surface in the sun or shade far exceed the desirable temperatures of about 75 degrees F. for the best strawberry plant growth. The average temperatures were progressively lower as the recording points were moved from the surface to one, 3 and 6 inches below the surface. The average temperature at 6 inches deep between plants was about 15 degrees F. cooler than the soil or mulch surface in the shade of the plant.

Soil temperatures for plots mulched with black plastic were about equivalent to those for check plots. The temperatures at various depths under the organic mulches were always cooler than the check or black plastic plots. These differences were usually 10 or more degrees F. These cooler temperatures were conducive to better plant growth and survival in the organic mulched plots.

Soil moisture normally is higher under organic mulches when drought conditions prevail. This condition was observed in these strawberry plots, as shown in Table 4. The moisture content of the soil under the plastic mulch tended to be higher than in the soil with clean cultivation.

Generally, fruit yields are directly proportional to plant size and vigor for strawberry plants grown by the hill system of culture. This was true for the plants in these mulched plots, Table 5. The highest yields were obtained from plants grown with organic mulches and the lowest yields were produced by plants with clean cultivation or black plastic mulch. The average berry size was largest for the plants grown under a pine straw mulch. Earliness as measured by the percentage of the total yield which was picked during the first three harvests indicated that the pine straw mulches resulted in later ripening.

The mulches had a marked influence on plant survival, as shown in Table 6. After two years in the field there was a heavy mortality of the plants in plots which received clean cultivation or were mulched with black plastic. At this time, less than half of the plants under these treatments were alive and even these surviving plants were low in vitality as shown in Figure 1. Both pine straw and sawdust mulches were beneficial to strawberry plant growth and survival. There were over 80% of the plants in these plots still alive and healthy at the end of the experiment.

Table 4. The influence of permanent mulches for strawberry plants on the percent of soil moisture in an area six inches from two live plants.

	Treatments					
Depth of soil sample	Check	Black Plastic	Pine Straw	Sawdust	L. S. D. .05	.01
1961 0-6"	11.91	13.51	15.23	12.97	3.4	5.2
6-12"	12.84	14.34	14.79	15.16	3.7	5.6
1962						
0-6"	10.84	13.54	10.98	12.03	3.3	5.1
6-12"	12.29	15.11	12.03	13.20	2.6	3.9
Average						
0-6"	11.37	13.52	13.10	12.50	2.8	4.2
6-12"	12.58	14.72	13.41	14.18	2.7	4.1

Soils were sampled on: September 19, 1961, following a 14 day period with .8 inch rainfall and a mean temperature of 72° F; and on July 9, 1962 following a 14 day period with .93 inch rainfall and a mean temperature of 81° F.

Table 5. The influence of permanent mulches on the yield of Pocahontas strawberry plants from May 2 to June 2 of first fruiting season.

Soil Treatment	Earliness Percent*	Yield Lbs. per row	Berries per Qt.
Check	73.5	5.0	124
Black Plastic	66.3	3.9	139
Pine Straw	33.6	9.4	93
Sawdust	56.7	8.7	110
L.S.D. .05	17.4	1.5	18.6
.01	26.4	2.3	28.1

*Earliness is expressed as the percent of the total which was picked on the first three harvest dates.

Table 6. The influence of permanent mulches on the survival of Pocahontas strawberry plants after two years.

Soil Treatment	Average Number of Plants per row	Percent Alive
Check	7.8	39.2
Black Plastic	9.0	45.0
Pine Straw	17.6	87.8
Sawdust	16.8	84.2
L.S.D. .05	4.5	20.9
.01	6.7	31.6

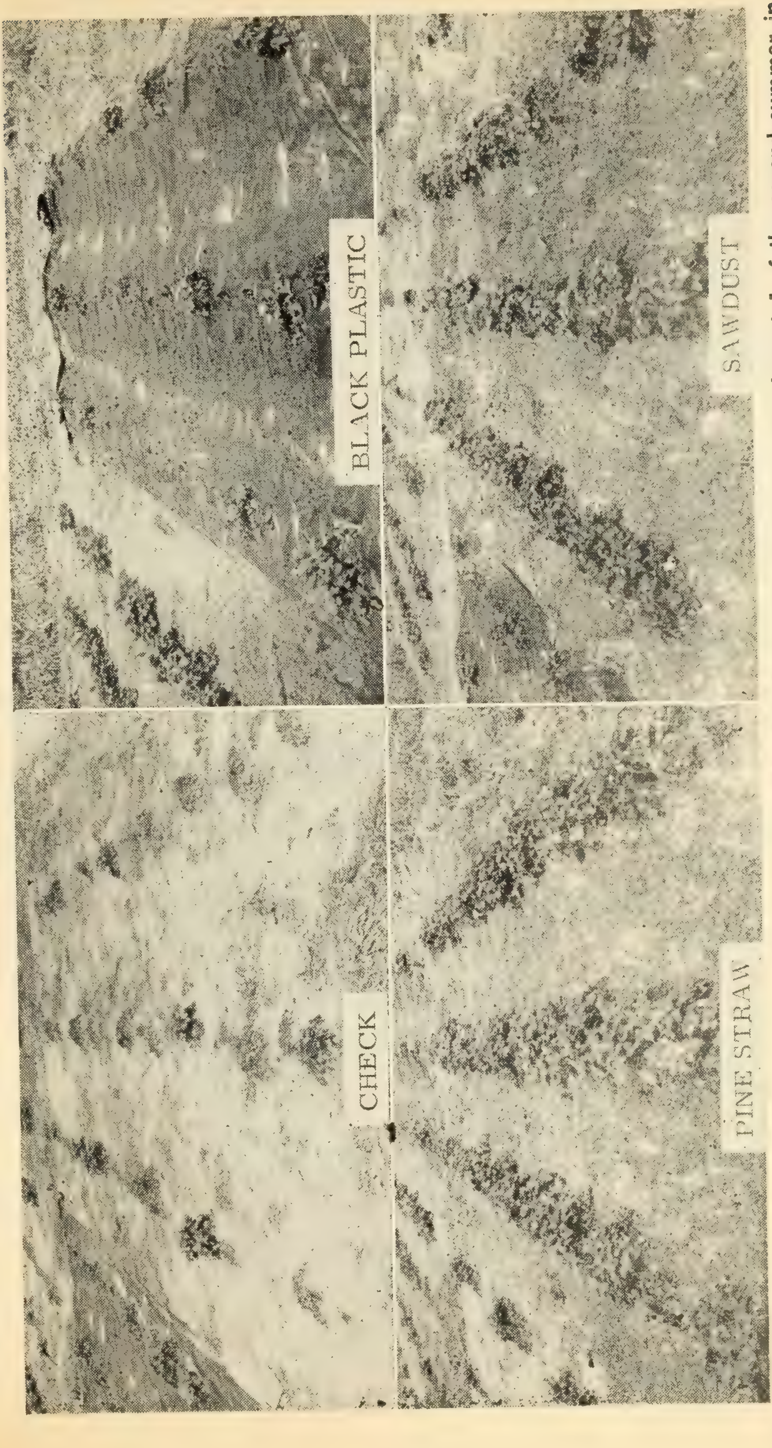
SAWDUST
PINE STRAW
BLACK PLASTIC
CHECK

Figure 1. The influence of permanent mulches on strawberry plant survival and vigor on August 1 of the second summer in test.

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An Analysis Of The Market For Tung Oil

By

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APPENDIX A

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An Analysis of the Market for Tung Oil

INTRODUCTION

China is the native land of tung trees and tung oil is frequently referred to as China wood oil. Tung trees were introduced into the U. S. during the 1900's. Increased use of tung oil as a drying agent gave impetus to heavy plantings of tung groves during the 1930's. The domestic tung industry is restricted to the Gulf Coastal Region of the United States. The heaviest concentration of production is in Mississippi, Florida, and Louisiana with more than one-half of the United States production concentrated in Mississippi. From 1956 to 1963 production of tung nuts in Mississippi ranged from 13,000 to 84,800 tons and the annual value ranged from 1.6 to 5.6 million dollars.[1] Even though the tung industry is comparatively small, it is the principal agricultural enterprise and provides a substantial part of the non-agricultural employment in some counties.

The Problem

Manufacturers of such products as oilcloth, paint and varnish, ink and insulating material afforded a ready market for domestically produced tung oil in early years. In recent years tung oil has suffered increasing competition from other products; these include both synthetic materials which were unknown only a few years ago and vegetable oils that were previously considered semi-drying oils. As a result, consumption of tung oil decreased. The productive life of tung trees in the Gulf Coastal Region normally does not exceed 30 to 40 years. Consequently, considerable acreages of tung trees are approaching the end of productive life. The owners of these lands are confronted with the question of whether groves should be re-established or whether lands should be devoted to other uses.

In order to answer this question, consideration must be given to the expected return from tung oil versus the expected return from alternative enterprises. The expected return for a particular enterprise is highly dependent upon the market for the product. This analysis is concerned with the market for tung oil.

Objectives

The purpose of this study was to evaluate the market potential for tung oil. The specific objectives were:

1. To measure changes in tung oil utilization and to evaluate the extent to which these changes resulted from raw material substitution and changes in product production.
2. To provide a basis for evaluating selected programs for the tung industry.
3. To evaluate the cost per gallon of product of substituting tung oil for other raw materials in protective coatings.
4. To describe changes in tung oil utilization for selected products other than protective coating.

Scope and Method

Input data for this study were obtained from a mail survey carried out by the Department of Agricultural Economics, Mississippi Agricultural Experiment Station during the Spring of 1965. These data combined with data available from secondary sources provided the basis for the study. For details of the research procedures used in this study, see Appendix A.

Annual changes in the amount of tung oil used by the protective coatings industry were evaluated for the period 1955-64. Annual changes in the utilization of tung oil for individual types of protective coatings were estimated for the period 1961-64. Changes in the amount of tung oil used per gallon of each type of protective coating were also determined for the period 1961-64. The analysis of the changes from 1961 to 1964 provided a basis for estimating the effects on tung oil utilization of raw material substitution and changes in the production of specific types of protective coatings. A summary of these changes is presented in Chapter II.

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[1] Mississippi Agricultural Statistics, p. 17.

Chapter III is devoted to a discussion of some programs that may be used to expand the utilization of tung oil in the protective coatings industry. These included a supply-price stabilization program and research-promotional programs.

Estimates of the additional cost that would be incurred by substituting tung oil for other raw materials were made. This analysis included an evaluation of the added cost of using specific levels of tung oil when other raw materials were selling at various prices. These estimates are presented in Chapter IV.

While this study was primarily concerned with the use of tung oil in protective coatings, some information relating to the usage of tung oil in special products was obtained. Utilization of tung oil in special products is discussed in Chapter V.

CHANGES IN UTILIZATION OF TUNG OIL

Both long - term and short - term changes in the utilization of tung oil were considered. The period considered for long-term changes was 1955-64. The period used to measure short-term changes was 1961-64. The long-term changes were concerned with total usage of tung oil for all products while the short-term changes dealt primarily with changes for specific types of products.

Long-Term Change

The Paint, Varnish and Lacquer Industry, the largest user of tung oil, consumed 23.6 million pounds in 1964 as compared to 42.6 million pounds in 1955; this change represents a decrease of over 44 percent (Table 1).

Annual volume purchased per plant consuming tung oil was estimated at 123 thousand pounds in 1955 as compared to 109 thousand pounds in 1964. This decrease, combined with a decrease in the number of plants consuming tung oil, accounted for the decrease in tung oil consumption. Trends in the number of reporting plants consuming tung oil from 1945-64 were calculated from survey data. Sixty-five of the reporting plants indicated that they used tung oil in exterior paints in 1945 compared to only 25 reporting plants using tung oil in this product in 1964. This same general trend applies to interior paint and industrial products finishes. The number of reporting plants using tung oil in major groups of products from 1945-64 is shown in Appendix B, Table 1.

The production of paint, varnish and lacquer in 1964 was approximately 10 percent higher than estimated production in 1955. In view of the upward trends in the production of paints, varnishes and lacquers, there appears to be only two possible explanations for the downward trends in tung oil utilization. If the relative importance of individual products included in each of these major categories has remained constant, then tung oil is being replaced by other raw materials. This type of change would obviously reduce the volume of tung oil per gallon of product. On the other hand, if the product composition for these major categories has changed, the production of products that require tung oil may have declined and thereby reduced the total utilization of tung oil.

Short-Term Changes

The average annual change in tung oil utilization and product production was estimated for individual products for the periods 1961-64 and 1958-63, respectively.[2] Products were classified into four major groups: exterior paints, interior paints, industrial product finishes and miscellaneous products.

Utilization of tung oil in protective coatings decreased by 188,200 gallons annually (Table 2). Over 97 percent of this decrease was the result of decreased usage in exterior paints and industrial product finishes. Utilization of tung oil decreased in interior paints by 5,800 gallons per year. Production of all three products increased. Tung oil utilization increased by 600 gallons for miscellaneous products.

Changes in tung oil consumption must be compared to changes in the production of individual products in order to determine where tung oil is being replaced by other raw materials and where its usage is declining because of corresponding decreases in product production. Major categories are, therefore, broken down into specific products.

Exterior Paints. This group of paints accounted for the utilization of more than one million gallons of tung oil in 1964. This was about one-third of the total tung oil used in the producton of protective coatings. This group included 10 specific types of products. For six of these products there were decreases in average annual utilization of tung oil ranging from 600 to 38,000 gallons (Table 3). The average annual increase for the remaining four products ranged from 600 to 4,200 gallons.

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[2] For procedures see part B, Section II, Appendix A.

Table 1. Number of plants using tung oil, utilization of tung oil and production of paints and varnish, 1955-64.

Year	Estimated number of plants consuming tung oil[1]	Average annual volume purchased per plant[2]	Apparent disappearance of tung oil[3]	Factory consumption of tung oil by the paint and varnish industry[4]	Production of paint varnish and lacquer[5]
	(number)	(..........	thousands of pounds	..........)	(thousands of gallons)
1955	408	123	50,185	42,636	657,135*
1956	407	126	51,261	43,689	634,723*
1957	379	128	48,463	39,676	612,132*
1958	294	135	39,637	31,805	594,600
1959	350	139	48,643	31,500	650,300
1960	295	135	39,810	29,600	663,100
1961	316	128	40,400	28,000	623,300
1962	282	119	33,500	25,200	643,400
1963	279	110	30,700	22,500	677,700
1964	286	109	31,200	23,600	724,600

[1] From Col. 5, Appendix B, Table 5.
[2] From Col. 3, Appendix B, Table 5.
[3] From Col. 6, Appendix B, Table 5.
[4] From Col. 4, Appendix B, Table 14.
[5] Furnished by National Paint, Varnish and Lacquer Association, except as noted.
*Estimates derived by adjusting the average price per gallon of paint, varnish and lacquer for the base period 1958-59 by Wholesale Price Index for 1958 and 1959 and relating these data to value of production data furnished by the National Paint, and Lacquer Association.

Table 2. Estimated utilization of tung oil and production of specified products for 1964 and annual changes in utilization and production.

	Estimated tung oil utilization		Estimated product production	
Product	Total for 1964	Average annual change from 1961 to 1964	Total for 1964	Average annual change 1958 to 1963
	(.....................	thousands of gallons	....	.)
Exterior paints[1]	1,022.7	—56.4	153,754.5	2,706.5
Interior paints[2]	959.1	— 5.8	160,405.2	6,869.2
Industrial product finishes[3]	1,034.8	—126.6	130,398.8	3,048.9
Miscellaneous products	9.1[4]	0.6[5]	NA[6]	NA[7]
Total	3,025.7	—188.2	444,558.5	12,624.6

[1] From Table 3.
[2] From Table 4.
[3] From Table 5.
[4] Data from Col. 2, Appendix B, Table 9, converted to gallons.
[5] Data from Col. 3, Appendix B, Table 6, converted to gallons.
[6] From Col. 1, Appendix B, Table 12.
[7] From Col. 6, Appendix B, Table 6.

Table 3. Exterior Paints: Estimated utilization of tung oil and production of specified products for 1964 and annual changes in utilization and production.

Product	Estimated tung oil utilization: Total for 1964[1]	Estimated tung oil utilization: Average annual change from 1961 to 1964[2]	Estimated product production: Total for 1964[3]	Estimated product production: Average annual change 1958 to 1963[4]
	(.................... thousands	of gallons	....	)
Oil and alkyd house paints and tinting bases	217.8	— 7.6	46,545.6	—579.4
Water emulsion paints and tinting bases	78.7	3.5	21,808.7	1,909.7
Exterior wood primers	96.8	— 1.2	12,167.2	580.2
Enamels and tinting bases	30.3	2.9	18,553.6	403.6
Varnishes, natural and synthetic	399.4	—38.0	4,210.6	—310.4
Automotive and machinery refinish paints, enamels and primers	39.3	— 4.8	37,957.0	NA
Traffic paints	9.1	— 0.6	9,620.6	550.6
Exterior marine paints	66.6	4.2	2,891.2	152.2
Exterior paints for metal	36.3	—15.4	NA	NA
Miscellaneous	48.4	0.6	NA	NA
Total	1,022.7	—56.4	153,754.5	2,706.5

[1]Data from Col. 2, Appendix B, Table 9, converted to gallons
[2]Data from Col. 3, Appendix B, Table 6, converted to gallons.
[3]From Col. 1, Appendix B, Table 12.
[4]From Col. 6, Appendix B, Table 6.

Table 4. Interior Paints: Estimated utilization of tung oil and production of specified products for 1964 and annual changes in utilization and production.

Product	Estimated tung oil utilization: Total for 1964[1]	Estimated tung oil utilization: Average annual change from 1961 to 1964[2]	Estimated product production: Total for 1964[3]	Estimated product production: Average annual change 1958 to 1963[4]
	(.................... thousands	of gallons	....	)
Oil and alkyd flat wall paints and tinting bases	0.0	*	22,160.0	—889.0
Oil and alkyd semi-gloss paints and tinting bases	0.0	— 3.6		
Oil and alkyd gloss and quick-drying enamels and tinting bases	111.9	2.6	35,757.8	1,111.8
Water emulsion paints and tinting bases	75.6	3.7	84,284.8	5,765.8
Undercoaters, primers and sealers	278.4	3.0	7,826.2	176.2
Varnishes, natural and synthetic	484.1	—13.3	10,066.4	704.4
Interior marine paints and enamels	9.1	1.8	310.0	NA
Miscellaneous	0.0	0.0	NA	NA
Total	959.1	— 5.8	160,405.2	6,869.2

[1]Data from Col. 2, Appendix B, Table 9, converted to gallons.
[2]Data from Col. 3, Appendix B, Table 6, converted to gallons.
[3]From Col. 1, Appendix B. Table 12.
[4]From Col. 6, Appendix B, Table 6.
*No respondent for 1961

Approximately 39 percent of the tung oil used in exterior paints in 1964 was for the production of natural and synthetic varnishes. Average production of varnish decreased by 310,400 gallons per year. Annual usage of tung oil for this product changed in a similar manner with an average decrease of 38,000 gallons. About 21 percent of the tung oil used in exterior paint in 1964 was for the production of oil and alkyd house paints and tinting bases. Average production of this product decreased by 579,400 gallons per year, while tung oil usage decreased by 7,600 gallons. These were the only types of exterior coatings with average annual decreases in production.

Annual usage of tung oil for the production of exterior wood primers and traffic paints also decreased. Although the volume of tung oil used in these items has been decreasing, production has been increasing. These were the only types of exterior paints with increases in production and decreases in tung oil utilization.

Utilization of tung oil for water emulsion paints and tinting bases, enamels and tinting bases, and exterior marine paints, has been increasing. Annual production of each of these products has also been increasing. They accounted for 17 percent of the tung oil used for exterior paints in 1964.

Interior Paints. The production of interior paints accounted for nearly one million gallons of tung oil in 1964 (Table 4). This group included eight specific types of products. For four of these products there were increases in average utilization of tung oil ranging from 1,800 to 3,700 gallons. There was no change in the utilization of tung oil for miscellaneous interior paints. Information on the utilization of tung oil in oil and alkyd flat wall paints and tinting bases was not available. The average annual decreases in utilization for the other two products were 3,600 and 13,300 gallons.

Natural and synthetic varnishes accounted for over half of the tung oil used for interior paints. Production of interior varnish has been increasing by approximately 704,400 gallons per year. Annual usage of tung oil for interior varnishes decreased by 13,300 gallons per year. Small quantities of tung oil were used in the production of oil and alkyd semi-gloss paints and tinting bases in 1961 but tung oil usage had declined to zero by 1964. These were the only types of interior paints with decreases in tung oil utilization.

Almost 50 percent of the tung oil used in interior paints was accounted for by products with an increasing utilization of tung oil. Approximately 29 percent of the oil used in interior paints was for undercoaters, primers and sealers. Production of this type of product increased 176,200 gallons per year. The highest rate of increase in tung oil utilization was for water emulsion paints and tinting bases. Production of water emulsion paints and tinting bases increased by over five million gallons annually. Utilization of tung oil for oil and alkyd gloss and quick-drying enamels and tinting bases and interior marine paints and enamels also increased. These were the only types of interior paints with increases in tung oil utilization.

Table 5. Industrial Product Finishes: Estimated utilization of tung oil and production of specified products for 1964 and annual changes in utilization and production.

	Estimated tung oil utilization		Estimated product production	
Product	Total for 1964[1]	Average annual change from 1961 to 1964[2]	Total for 1964[3]	Average annual change 1958 to 1963[4]
	(....................	thousands of gallons	....	)
Wood furniture and fixtures	45.4	3.2	7,507.0	NA
Metal furniture and fixtures	0.0	*	13,717.1	NA
Sheet, strip and coil coatings	0.0	*	7,989.0	NA
Appliances	0.0	*	10,621.4	664.4
Automotive	54.5	—10.6	29,172.0	1,671.0
Railroads	0.0	*	8,601.6	NA
Toys, sporting goods, gym and baby equipment	3.0	— 1.4	2,015.9	NA
Machinery and equipment	9.1	— 4.2	12,474.0	NA
Insulating varnish	638.4	—25.3	6,140.0	524.7
Can coatings	63.5	—24.3	NA	NA
Wrinkle varnish**	9.1	3.0	4,589.6	—1,402.4
Undercoaters and primers	190.6	—69.3	27,571.2	1,591.2
Miscellaneous	21.2	2.3	NA	NA
Total	1,034.8	—126.6	130,398.8	3,048.9

[1] Data from Col. 2, Appendix B, Table 9, converted to gallons.
[2] Data from Col. 3, Appendix B, Table 6, converted to gallons.
[3] From Col. 1, Appendix B, Table 12.
[4] From Col. 6, Appendix B, Table 6.
*No respondent for 1961.
**Since wrinkle varnish was not clearly identified on the questionnaire, estimated tung oil consumption was considered to be understated.

Industrial Product Finishes. This group of paints accounted for the utilization of more than one million gallons of tung oil in 1964 (Table 5). This group included 13 specific types of products. Average annual changes in tung oil utilization could not be estimated for four of these products. Tung oil utilization increased for only three products. These increases ranged from 2,300 to 3,200 gallons. For six products there were decreases in average annual utilization ranging from 1,400 to 69,300 gallons.

Approximately 62 percent of the tung oil used in industrial product finishes in 1964 was for the production of insulating varnish. Average production of this varnish increased by 524,700 gallons per year but annual usage of tung oil in this product decreased 25,300 gallons. Over 18 percent of the tung oil used in industrial product finishes in 1964 was for the production of undercoaters and primers. Average production of this product increased by 1,591,200 gallons per year while tung oil usage decreased by 69,300 gallons. Tung oil utilization also decreased for automotive finishes, can coatings, finishes for machinery and equipment and finishes for toys, sporting goods, gym and baby equipment.

Wrinkle varnish was the only industrial product finish where tung oil utilization increased while production decreased. Annual utilization of tung oil in wrinkle varnish increased by 3,000 gallons and production decreased by 1,402,400 gallons. The only other product which accounted for increases in annual tung oil utilization were finishes for wood furniture and fixtures and miscellaneous industrial product finishes. Annual increases in utilization for these two products were 3,200 and 2,300 gallons respectively.

Per Unit Changes

The analysis in the preceding section indicates considerable changes in the volume of tung oil used and in the production of specific types of products. It is difficult to ascertain the extent to which tung oil is replaced by other materials when considering changes in the total market. Changes in tung oil utilization per unit of product provide a measure of the extent to which tung oil was replaced by other raw materials.

Exterior Paints. There were no significant changes in the usage of tung oil per gallon for exterior paints (Table 6). There were slight increases in the utilization of tung oil per gallon of product for enamels and tinting bases, automotive refinish paints, enamels and primers and exterior marine paints and enamels. Tung oil usage per gallon of product decreased slightly for the other types of exterior paint.

Interior Paints. Marine paints and enamels was the only type of interior paint with an increase in tung oil utilization per gallon of product (Table 7). Natural and synthetic varnishes was the

Table 6. Exterior paints: Utilization of tung oil per gallon of U.S. production of specified products, 1961 and 1964.

Product	Estimated usage of tung oil per gallon of product	
	1961[1]	1964[2]
	(........ pounds per gallon	........)
Oil and alkyd house paints and tinting bases	0.039	0.037
Water emulsion paints and tinting bases	0.033	0.028
Exterior wood primers	0.075	0.062
Enamels and tinting bases	0.010	0.013
Varnishes, natural and synthetic	0.779	0.740
Automotive and machinery refinish paints, enamels and primers	0.006	0.008
Traffic paints	0.011	0.007
Exterior marine paints and enamels	0.173	0.180
Exterior paints for metal	NA	NA
Miscellaneous	NA	NA

[1] From Col. 3, Appendix B, Table 11.
[2] From Col 3. Appendix B. Table 12.

estimated for individual products for the periods 1961-64 and 1958-63, respectively.[2] Products were classified into four major groups: exterior paints, interior paints, industrial product finishes and miscellaneous products.

Utilization of tung oil in protective coatings decreased by 188,200 gallons annually (Table 2). Over 97 percent of this decrease was the result of decreased usage in exterior paints and industrial product finishes. Utilization of tung oil decreased in interior paints by 5,800 gallons per year. Production of all three products increased. Tung oil utilization increased by 600 gallons for miscellaneous products.

Changes in tung oil consumption must be compared to changes in the production of individual products in order to determine where tung oil is being replaced by other raw materials and where its usage is declining because of corresponding decreases in product production. Major categories are, therefore, broken down into specific products.

Exterior Paints. This group of paints accounted for the utilization of more than one million gallons of tung oil in 1964. This was about one-third of the total tung oil used in the producton of protective coatings. This group included 10 specific types of products. For six of these products there were decreases in average annual utilization of tung oil ranging from 600 to 38,000 gallons (Table 3). The average annual increase for the remaining four products ranged from 600 to 4,200 gallons.

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[2] For procedures see part B, Section II, Appendix A.

Table 1. Number of plants using tung oil, utilization of tung oil and production of paints and varnish, 1955-64.

Year	Estimated number of plants consuming tung oil[1]	Average annual volume purchased per plant[2]	Apparent disappearance of tung oil[3]	Factory consumption of tung oil by the paint and varnish industry[1]	Production of paint varnish and lacquer[5]
	(number)	(..........thousands of pounds..........)			(thousands of gallons)
1955	408	123	50,185	42,636	657,135*
1956	407	126	51,261	43,689	634,723*
1957	379	128	48,463	39,676	612,132*
1958	294	135	39,637	31,805	594,600
1959	350	139	48,643	31,500	650,300
1960	295	135	39,810	29,600	663,100
1961	316	128	40,400	28,000	623,300
1962	282	119	33,500	25,200	643,400
1963	279	110	30,700	22,500	677,700
1964	286	109	31,200	23,600	724,600

[1] From Col. 5, Appendix B, Table 5.
[2] From Col. 3, Appendix B, Table 5.
[3] From Col. 6, Appendix B, Table 5.
[4] From Col. 4, Appendix B, Table 14.
[5] Furnished by National Paint, Varnish and Lacquer Association, except as noted.
*Estimates derived by adjusting the average price per gallon of paint, varnish and lacquer for the base period 1958-59 by Wholesale Price Index for 1958 and 1959 and relating these data to value of production data furnished by the National Paint, and Lacquer Association.

Table 2. Estimated utilization of tung oil and production of specified products for 1964 and annual changes in utilization and production.

	Estimated tung oil utilization		Estimated product production	
Product	Total for 1964	Average annual change from 1961 to 1964	Total for 1964	Average annual change 1958 to 1963
	(.................... thousands of gallons ....)			
Exterior paints[1]	1,022.7	—56.4	153,754.5	2,706.5
Interior paints[2]	959.1	— 5.8	160,405.2	6,869.2
Industrial product finishes[3]	1,034.8	—126.6	130,398.8	3,048.9
Miscellaneous products	9.1[4]	0.6[5]	NA[6]	NA[7]
Total	3,025.7	—188.2	444,558.5	12,624.6

[1] From Table 3.
[2] From Table 4.
[3] From Table 5.
[4] Data from Col. 2, Appendix B, Table 9, converted to gallons.
[5] Data from Col. 3, Appendix B, Table 6, converted to gallons.
[6] From Col. 1, Appendix B, Table 12.
[7] From Col. 6, Appendix B, Table 6.

Table 3. Exterior Paints: Estimated utilization of tung oil and production of specified products for 1964 and annual changes in utilization and production.

	Estimated tung oil utilization		Estimated product production	
Product	Total for 1964[1]	Average annual change from 1961 to 1964[2]	Total for 1964[3]	Average annual change 1958 to 1963[4]
	(.................... thousands of gallons		....	)
Oil and alkyd house paints and tinting bases	217.8	—7.6	46,545.6	—579.4
Water emulsion paints and tinting bases	78.7	3.5	21,808.7	1,909.7
Exterior wood primers	96.8	—1.2	12,167.2	580.2
Enamels and tinting bases	30.3	2.9	18,553.6	403.6
Varnishes, natural and synthetic	399.4	—38.0	4,210.6	—310.4
Automotive and machinery refinish paints, enamels and primers	39.3	—4.8	37,957.0	NA
Traffic paints	9.1	—0.6	9,620.6	550.6
Exterior marine paints	66.6	4.2	2,891.2	152.2
Exterior paints for metal	36.3	—15.4	NA	NA
Miscellaneous	48.4	0.6	NA	NA
Total	1,022.7	—56.4	153,754.5	2,706.5

[1]Data from Col. 2, Appendix B, Table 9, converted to gallons.
[2]Data from Col. 3, Appendix B, Table 6, converted to gallons.
[3]From Col. 1, Appendix B, Table 12.
[4]From Col. 6, Appendix B, Table 6.

Table 4. Interior Paints: Estimated utilization of tung oil and production of specified products for 1964 and annual changes in utilization and production.

	Estimated tung oil utilization		Estimated product production	
Product	Total for 1964[1]	Average annual change from 1961 to 1964[2]	Total for 1964[3]	Average annual change 1958 to 1963[4]
	(.................... thousands of gallons		....	)
Oil and alkyd flat wall paints and tinting bases	0.0	*	22,160.0	—889.0
Oil and alkyd semi-gloss paints and tinting bases	0.0	—3.6	35,757.8	1,111.8
Oil and alkyd gloss and quick-drying enamels and tinting bases	111.9	2.6		
Water emulsion paints and tinting bases	75.6	3.7	84,284.8	5,765.8
Undercoaters, primers and sealers	278.4	3.0	7,826.2	176.2
Varnishes, natural and synthetic	484.1	—13.3	10,066.4	704.4
Interior marine paints and enamels	9.1	1.8	310.0	NA
Miscellaneous	0.0	0.0	NA	NA
Total	959.1	—5.8	160,405.2	6,869.2

[1]Data from Col. 2, Appendix B, Table 9, converted to gallons.
[2]Data from Col. 3, Appendix B, Table 6, converted to gallons.
[3]From Col. 1, Appendix B. Table 12.
[4]From Col. 6, Appendix B, Table 6.
*No respondent for 1961

Approximately 39 percent of the tung oil used in exterior paints in 1964 was for the production of natural and synthetic varnishes. Average production of varnish decreased by 310,400 gallons per year. Annual usage of tung oil for this product changed in a similar manner with an average decrease of 38,000 gallons. About 21 percent of the tung oil used in exterior paint in 1964 was for the production of oil and alkyd house paints and tinting bases. Average production of this product decreased by 579,400 gallons per year, while tung oil usage decreased by 7,600 gallons. These were the only types of exterior coatings with average annual decreases in production.

Annual usage of tung oil for the production of exterior wood primers and traffic paints also decreased. Although the volume of tung oil used in these items has been decreasing, production has been increasing. These were the only types of exterior paints with increases in production and decreases in tung oil utilization.

Utilization of tung oil for water emulsion paints and tinting bases, enamels and tinting bases, and exterior marine paints, has been increasing. Annual production of each of these products has also been increasing. They accounted for 17 percent of the tung oil used for exterior paints in 1964.

Interior Paints. The production of interior paints accounted for nearly one million gallons of tung oil in 1964 (Table 4). This group included eight specific types of products. For four of these products there were increases in average utilization of tung oil ranging from 1,800 to 3,700 gallons. There was no change in the utilization of tung oil for miscellaneous interior paints. Information on the utilization of tung oil in oil and alkyd flat wall paints and tinting bases was not available. The average annual decreases in utilization for the other two products were 3,600 and 13,300 gallons.

Natural and synthetic varnishes accounted for over half of the tung oil used for interior paints. Production of interior varnish has been increasing by approximately 704,400 gallons per year. Annual usage of tung oil for interior varnishes decreased by 13,300 gallons per year. Small quantities of tung oil were used in the production of oil and alkyd semi-gloss paints and tinting bases in 1961 but tung oil usage had declined to zero by 1964. These were the only types of interior paints with decreases in tung oil utilization.

Almost 50 percent of the tung oil used in interior paints was accounted for by products with an increasing utilization of tung oil. Approximately 29 percent of the oil used in interior paints was for undercoaters, primers and sealers. Production of this type of product increased 176,200 gallons per year. The highest rate of increase in tung oil utilization was for water emulsion paints and tinting bases. Production of water emulsion paints and tinting bases increased by over five million gallons annually. Utilization of tung oil for oil and alkyd gloss and quick-drying enamels and tinting bases and interior marine paints and enamels also increased. These were the only types of interior paints with increases in tung oil utilization.

Table 5. Industrial Product Finishes: Estimated utilization of tung oil and production of specified products for 1964 and annual changes in utilization and production.

	Estimated tung oil utilization		Estimated product production	
Product	Total for 1964[1]	Average annual change from 1961 to 1964[2]	Total for 1964[3]	Average annual change 1958 to 1963[1]
	(.................... thousands of gallons		....	)
Wood furniture and fixtures	45.4	3.2	7,507.0	NA
Metal furniture and fixtures	0.0	*	13,717.1	NA
Sheet, strip and coil coatings	0.0	*	7,989.0	NA
Appliances	0.0	*	10,621.4	664.4
Automotive	54.5	—10.6	29,172.0	1,671.0
Railroads	0.0	*	8,601.6	NA
Toys, sporting goods, gym and baby equipment	3.0	— 1.4	2,015.9	NA
Machinery and equipment	9.1	— 4.2	12,474.0	NA
Insulating varnish	638.4	—25.3	6,140.0	524.7
Can coatings	63.5	—24.3	NA	NA
Wrinkle varnish**	9.1	3.0	4,589.6	—1,402.4
Undercoaters and primers	190.6	—69.3	27,571.2	1,591.2
Miscellaneous	21.2	2.3	NA	NA
Total	1,034.8	—126.6	130,398.8	3,048.9

[1] Data from Col. 2, Appendix B, Table 9, converted to gallons.
[2] Data from Col. 3, Appendix B, Table 6, converted to gallons.
[3] From Col. 1, Appendix B, Table 12.
[4] From Col. 6, Appendix B, Table 6.
*No respondent for 1961.
**Since wrinkle varnish was not clearly identified on the questionnaire, estimated tung oil consumption was considered to be understated.

Industrial Product Finishes. This group of paints accounted for the utilization of more than one million gallons of tung oil in 1964 (Table 5). This group included 13 specific types of products. Average annual changes in tung oil utilization could not be estimated for four of these products. Tung oil utilization increased for only three products. These increases ranged from 2,300 to 3,200 gallons. For six products there were decreases in average annual utilization ranging from 1,400 to 69,300 gallons.

Approximately 62 percent of the tung oil used in industrial product finishes in 1964 was for the production of insulating varnish. Average production of this varnish increased by 524,700 gallons per year but annual usage of tung oil in this product decreased 25,300 gallons. Over 18 percent of the tung oil used in industrial product finishes in 1964 was for the production of undercoaters and primers. Average production of this product increased by 1,591,200 gallons per year while tung oil usage decreased by 69,300 gallons. Tung oil utilization also decreased for automotive finishes, can coatings, finishes for machinery and equipment and finishes for toys, sporting goods, gym and baby equipment.

Wrinkle varnish was the only industrial product finish where tung oil utilization increased while production decreased. Annual utilization of tung oil in wrinkle varnish increased by 3,000 gallons and production decreased by 1,402,400 gallons. The only other product which accounted for increases in annual tung oil utilization were finishes for wood furniture and fixtures and miscellaneous industrial product finishes. Annual increases in utilization for these two products were 3,200 and 2,300 gallons respectively.

Per Unit Changes

The analysis in the preceding section indicates considerable changes in the volume of tung oil used and in the production of specific types of products. It is difficult to ascertain the extent to which tung oil is replaced by other materials when considering changes in the total market. Changes in tung oil utilization per unit of product provide a measure of the extent to which tung oil was replaced by other raw materials.

Exterior Paints. There were no significant changes in the usage of tung oil per gallon for exterior paints (Table 6). There were slight increases in the utilization of tung oil per gallon of product for enamels and tinting bases, automotive refinish paints, enamels and primers and exterior marine paints and enamels. Tung oil usage per gallon of product decreased slightly for the other types of exterior paint.

Interior Paints. Marine paints and enamels was the only type of interior paint with an increase in tung oil utilization per gallon of product (Table 7). Natural and synthetic varnishes was the

Table 6. Exterior paints: Utilization of tung oil per gallon of U.S. production of specified products, 1961 and 1964.

Product	Estimated usage of tung oil per gallon of product 1961[1]	 1964[2]
	(........ pounds per gallon	........)
Oil and alkyd house paints and tinting bases	0.039	0.037
Water emulsion paints and tinting bases	0.033	0.028
Exterior wood primers	0.075	0.062
Enamels and tinting bases	0.010	0.013
Varnishes, natural and synthetic	0.779	0.740
Automotive and machinery refinish paints, enamels and primers	0.006	0.008
Traffic paints	0.011	0.007
Exterior marine paints and enamels	0.173	0.180
Exterior paints for metal	NA	NA
Miscellaneous	NA	NA

[1] From Col. 3, Appendix B, Table 11.
[2] From Col 3, Appendix B, Table 12.

type of industrial product finish where there were decreases in tung oil usage resulting from raw material substitution and increases because of increased production. Thus, the net effect of both raw material substitution and changes in product production for these three products was the reduction of tung oil utilization by 315,400 gallons.

Wrinkle varnish was the only industrial product finish where increases in tung oil usage could be attributed to raw material substitution. The usage of tung oil for wrinkle varnish increased by approximately 9,100 gallons during the 1961-64 period. This increase was entirely the result of substitution effects since no change in tung oil usage could be attributed to changes in product production. It should be noted that the information obtained for wrinkle varnish was probably not as complete as it would have been if this product had been clearly identified on the questionnaire.

In summary, the market for tung oil as a raw material for exterior paints, interior paints and industrial product finishes declined by 564,300 gallons from 1961-to 1964. The analysis presented in these sections indicate that much of the loss in tung oil utilization was the result of raw material substitution. If these markets for tung oil are to be recovered or new markets established, organized effort by the tung industry will be needed. Some selected programs are considered in the next chapter.

PROGRAMS FOR THE TUNG INDUSTRY

The domestic tung industry is highly organized. There are currently four different but closely related associations serving tung producers. These are the American Tung Oil Association, the Tung Research and Development League, the National Tung Oil Marketing Cooperative and the Pan American Tung Research and Development League. All of these are active associations and each is engaged in promoting one or more programs designed to increase the utilization of tung oil in protective coatings. However, these associations are confronted with the problem of deciding on the particular types of programs that will be most effective. The suggestions and recommendations provided by the protective coatings industry through the survey should be carefully considered.

Recommendations From The Protective Coatings Industry

Respondents were asked if they had any comments or suggestions about the present or future of tung oil in the paint industry. Fifty-five of the plants surveyed responded to this question by making voluntary recommendations to the tung industry. Since some of these recommendations were made repeatedly, they have been presented in tabular form (Table 13).

Table 13. Percentage distribution of plants making recommendations, by type of recommendation, 55 plants.

Recommendations	Percent of plants making recommendations
	(percent)
Lower price	72.7
Stabilize supply	23.6
Stabilize price	34.5
Re-educate industry	9.1
Place selling effort on large vehicle manufacturers	1.8
Standardize grades	3.6
Number of plants making recommendations	55

Source: Survey data.

Over 72 percent of the plants giving recommendations felt that tung oil should be supplied at a lower price. Supply and price stabilization were the next most frequently given recommendations. Other suggestions were that grade standardization and educational programs be initiated. One respondent suggested that the tung industry place major selling effort on large paint vehicle manufacturers. Production of paint vehicles is an intermediate processing stage in the manufacture of paints. Five plants indicated that one of the reasons tung oil consumption has been declining is that the current generation of paint technicians do not understand the true merits and best usage of tung oil. One respondent expressed this idea extremely well:

> "It seems to me that the generation that understood the the true merits and best usage of tung-oil has nearly passed and that the great majority of present-day formulators do not understand or appreciate tung-oil.
>
> As a result of this, I bebelieve that an extensive re-educational program would be of great value to the tung-oil industry. Having been walled-up in a torrent of soya, linseed, safflower, and tall-oil alkyd as well as epoxies, polyurethanes, and many latex polymers, etc., today's "kids" do not really know much about tung-oil."

These recommendations are supported by some of the data presented in this study. Over 86 percent of the tung oil accounted for by the survey in 1964 was purchased by 26 percent of the plants surveyed (Appendix B, Tables 3 and 4). This indicates that a few large companies account for a great deal of the tung oil consumed in the production of finished products. Since large companies consume a great proportion of tung oil, consideration should be given to the concentration of sales effort on large manufacturers.

Recommendations indicate that a supply-price stabilization program should be successful in promoting tung oil utilization. In order to provide some information on what to expect from stabilized supplies and prices, an anaylsis of the increase in tung oil utilization that would be expected for specific products was conducted.

Supply-Price Stabilization Program

Stabilization of tung oil supplies involves technical problems as well as economic consideration. Tung trees are sensitive to cold weather and at times cold damage to the nut crop is severe. During years when production was substantially reduced by late frosts, tung oil supplies have not been adequate to provide oil at prices competitive with other raw materials.

Apparent disappearance of tung oil in 1964 was only 31.2 million pounds compared to 40.4 million pounds in 1961 (Table 1). Average price for 1964 was reported as 26.7 cents per pound f. o. b. domestic mills (Appendix B, Table14).

Plants receiving questionnaires were asked to estimate the quantity of tung oil they would have used in individual products in 1964 if an effective supply-price stabilization program had been in effect for several years. Percentage changes in the utilization of tung oil were calculated from these data (Appendix B, Table 15). These percentages were applied to estimated tung oil consumption data for 1964 in order to evaluate the effects of a supply-price stabilization program on utilization of tung oil for each product (Table 14).

Exterior Paints. The greatest increase in utilization was for the exterior paint group. There were increases in tung oil utilization for seven products and no change in utilization was indicated for three products. Natural and synthetic exterior varnishes accounted for the greatest increase in tung oil usage for the exterior paint group. This increase in the utilization of tung oil would have been over one-half million pounds if consumers had been assured of adequate supplies and stabilized prices of not over 30 cents per pound for several years.

Interior Paints. Under a stabilization program, the increase in utilization of tung oil in interior paints was estimated to be 13.4 percent. Most of this increase was in natural and synthetic interior varnishes. There was an indicated decrease of 7.3 percent in the utilization of tung oil for interior undercoaters and primers. In

Table 14. Effects of supply - price stabilization program on tung oil utilization by product, 1974. Exterior Paints

Product	Change from actual situation to supply - price stabilization program[1]	Estimated tung oil consumption in 1964	
		Actual[2]	After stabilization
Exterior Paints	(percent)	(thousands of pounds)	
Oil and alkyd paints and tinting bases	12.5	1,699.2	1,911.6
Water emulsion paints and tinting bases	0.0	613.6	613.6
Exterior wood primers	1.1	755.2	763.5
Varnishes, natural and synthetic	17.4	3,115.2	3,657.2
Automotive anl machinery refinish enamels and primers	64.5	306.8	504.7
Traffic paints	100.0	519.2	557.6
Exterior marine paints and enamels	7.4	519.2	557.6
Exterior paints for metal	0.0	377.6	377.6
Total Exterior Paints	(14.7)	7,976.8	9,149.1
Interior Paints			
Oil and alkyd flat wall paints and tinting bases	*	0.0	0.0**
Oil and alkyd semi-gloss paints and pinting bases	0.0	0.0	0.0
Oil and alkyd gloss and quick-drying enamels and tinting bases	24.0	873.2	1,082.8
Water emulsion paints and tinting bases	0.0	590.0	590.0
Undercoaters, primers and sealers	—7.3	2,171.2	2,012.7
Varnishes, natural and synthetic	25.1	3,776.0	4,723.8
Interior marine paints and enamels	*	70.8	10.8**
Miscellaneous	0.0	0.0	0.0
Total Interior Paints	(13.4)	7,481.2	8,480.1
Industrial Product Finishes			
Wood furniture and fixtures	8.3	354.0	383.4
Metal furniture and fixtures	*	0.0	0.0**
Sheet, strip and coil coatings	*	0.0	0.0**
Appliances	*	0.0	0.0**
Automotive	0.0	424.8	424.8
Railroads	*	0.0	0.0**
Toys, sporting goods, gym and baby equipment	60.0	23.6	37.8
Machinery and equipment	0.0	70.8	70.8
Insulating varnish	3.1	4,979.6	5,134.0
Can Coatings	—69.4	49f.6	151.7
Wrinkle varnish***	*	70.8	70.8**
Undercoaters and primers	*	1,486.8	1,486.8**
Miscellaneous	0.0	8,071.2	7,957.3
Total Industrial Product Finishes	(—1.8)	8,071.2	7,925.3
Miscellaneous Products	0.0	70.8	70.8
Total - All Products	(8.6)	23,600.0	25,625.3

[1] From Col. 4, Appendix B, Table 15 except percentage changes for numbers in parenthesis were calculated from CCol. 2 and Col. 3 of this table.

[2] From Col. 2, Appendix B, Table 6.

*Respondent did not provide information on the affect of a supply - price stabilization program.

**Since percentage change data were not available, we assumed zero change.

***Since wrinkle varnish was not clearly identified on the questionnaire, reported utilizaton was considered to be a low estimate.

terior oil and alkyd gloss and quick-drying enamel and tinting base was the only other type of interior paint affected by the assumption of supply - price stabilization. There was a 24 percent increase in the utilization of tung oil by this type of product.

Industrial Product Finishes. Utilization of tung oil in industrial product finishes decreased 1.8 percent after supply and price were assumed stabilized. This overall decrease in utilization was the result of a 69.4 percent decrease in the use of tung oil for can coatings.

Total Stabilization Effects. _The above analysis indicates that if tung oil consumers had been assured of an adequate supply and stabilized prices not exceeding 30 cents per pound, consumption of tung oil would have increased 8.6 percent in 1964. This represented an increase in consumption of tung oil of over two million pounds for the year. This goal could perhaps be achieved through the establishment of an effective supply-price stabilization program.

Development Programs

An entirely different array of market goals may be established through research and promotional programs oriented toward the quality attributes of tung oil as a raw material for protective coatings. The tung industry has already initiated both research and promotional programs with primary emphasis on the relative merits of tung oil as a raw material for protective coatings.

Some of the information obtained from the survey supports the hypothesis that tung oil is a superior raw material for the manufacture of many types of protective coatings. Forty of the respondents volunteered an opinion as to the merits of tung oil relative to other available raw materials (Table 15). Seventy percent of those volunteering an opinion stated that tung oil was a superior ingredient for some or all of the products they produced. About 25 percent considered tung oil to be an average ingredient and only 5 percent classified it as a poor raw material.

Table 15. Voluntary opinions of tung oil merit as compared to the merit of other raw material.

Opinion	Percent of respondents volunteering an opinion
	(percent)
Superior raw material	70
Average raw material	25
Poor raw material	5
Number of respondents volunteering an opinion	40

Source: Survey data.

The research program of the tung industry is carried out by the Pan American Tung Research and Development League's research laboratory at the University of Southern Mississippi, Hattiesburg, Mississippi. This organization maintains a staff of paint chemists and its primary function is the development of high quality formulations for various types of protective coatings. Formulations developed by this organization are currently available to the protective coatings industry for some of the products considered in this study. These proposed formulations for high quality products were used in this study to indicate the potential usage of tung oil in specific products (Table 16). Comparison of the amount of tung oil that would be utilized in these formulations to the amount of tung oil actually used in 1964 should point out some of the areas where there is greatest potential for tung oil.

If all products in 1964 had been formulated with the proposed contents of tung oil, total consumption would have exceeded 156 million pounds. However, it must be recognized that there is a demand for less expensive types of protective coatings. Therefore, if one can establish from the quality attributes of tung oil realistic proportions of the products that should be based on high quality tung oil formulations, then realistic estimates of potential tung oil usage may be calculated from information presented in Appendix B, Table 13. Proposed formulations also

Table 16. Pounds of tung oil required per gallon for specified products for proposed formulations and potential production for 1964 based on proposed formulations as a percent of actual production in 1964.

Product	Tung oil usage per gallon of product in 1964[1]	Proposed formulations: Tung oil requirements[2]	Proposed formulations: Potential production
	(............ lbs./gal.	....	(Percent of 1964 production)
Exterior Paints			
Oil and alkyd house paints and tinting bases	0.037	0.60	6.1
Water emulsion paints and tinting bases	0.028	0.50	5.6
Exterior wood primers	0.062	0.60	10.3
Enamels and tinting bases	0.013	0.50	2.5
Varnishes, natural and synthetic	0.740	2.00	37.0
Automotive and machinery refinish paints, enamels and primers	0.008	0.50	1.6
Traffic paints	0.007	1.00	0.7
Exterior marine paints	0.180	0.75	23.9
Interior Paints			
Undercoaters, primers and sealers	0.277	0.50	55.5
Varnishes, natural and synthetic	0.375	2.40	15.6
Industrial Product Finishes			
Wrinkle varnish	0.015	1.00	1.5
Undercoaters and primers	0.054	0.75	7.2

[1] From Col. 2, Appendix B, Table 12.
[2] From Col. 2, Appendix B, Table 13.

served as the basis for estimating the maximum amount of high quality product that could have been produced in 1964 assuming that tung oil usage remained constant.

Potential tung oil usage per gallon of product and the proportion of production that might have been high quality products based on proposed formulations indicates the areas where tung oil usage may be best developed. This information used in conjunction with changes in tung oil usage resulting from raw material substitution and changes in production should provide a basis for the tung industry to select specific areas for concentrated research and promotional efforts.

The choice of area in which to concentrate future efforts should be governed by the merits of tung oil relative to other raw materials. Trends in the production of specific production should also be considered an important factor when planning development programs. Technical information in the quality attributes of tung oil should provide an indication of whether the additional cost of using tung oil is offset by improvements in product quality Costs are considered in the next chapter.

RELATIVE COST OF TUNG OIL

The recommendations presented in Chapter III indicate that one of the primary factors affecting the utilization of tung oil is its cost relative to other ingredients. As indicated earlier, tung oil is generally considered a superior raw material for the manufacture of many types of protective coatings. Because of the quality attributes of tung oil, one would expect its price to be high relative to other ingredients. Although the price of tung oil is high relative to other raw materials, the substitution of tung oil for lower cost raw materials results in relatively small increases in the final product cost since only a small quantity of tung oil is required. The purpose of this chapter is to evaluate the cost per gallon of finished product if tung oil is used rather than other ingredients.

The products selected were those for which the required data were available. Added costs were based on the amount of tung oil required for the proposed formulations referred to in the preceding chapter and prices of tung oil of 30 cents per pound. Six price levels for other ingredients ranging from 12 cents to 27 cents per pound were considered.

The added cost was largest for those products requiring largest amounts of tung oil for any specified price of alternative raw materials. The added cost of using tung oil for a product varied inversely with th price of other raw materials. For example, the highest proposed volume of tung oil was 2.4 pounds per gallon, which was for interior varnish and the additional cost of using tung oil rather than other ingredients costing 27 cents per pound was 7.2 cents per gallon (Table 17). Comparisons of this type may be made for other products from information presented in this chapter.

Since the price of tung oil fluctuates, the costs presented in Table 17 may not be appropriate at a given period of time. Information of the same type has been developed in Table 18. Assuming a given usage of tung oil per gallon of product and knowing the difference between the cost of tung oil and other ingredients, one can determine the additional cost of tung oil per gallon of product produced from the information presented in Table 18. This information provides an easy method of determining the additional cost of using varying quantities of tung oil relative to other raw materials.

The above analysis of added cost provides only part of the information needed to specify the areas of greatest potential for tung oil utilization. It has been pointed out previously that potential utilization of tung oil is dependent upon its quality attributes for protective coatings.

Table 17. Added cost of employing proposed formulations by product, 1964.

Product	Proposed usage of tung oil per gallon of product[1]	Additional cost per gallon of product if specified amounts of tung oil costing 30c per gallon is used rather than other ingredients selling at specified prices[2]					
		12c/lb.	15c/lb.	18c/lb.	21c/lb.	24c/lb.	27c/lb.
	(lbs. per gal.)	(additional cost of product in cents per gallon)					
Exterior Paints							
Oil and alkyd paints and tinting bases	0.600	10.8	9.0	7.2	5.4	3.6	1.8
Water emulsion paints and tinting bases	0.500	9.0	7.4	6.0	4.5	3.0	1.5
Exterior wood primers	0.600	10.8	9.0	7.2	5.4	3.6	1.8
Enamels and tinting bases	0.500	9.0	7.4	6.0	4.5	3.0	1.5
Varnishes, natural and synthetic	2.000	36.0	30.0	24.0	18.0	12.0	6.0
Automotive and machinery refinish paints, enamels and primers	0.500	9.0	7.4	6.0	4.5	3.0	1.5
Traffic paints	1.000	18.0	15.0	12.0	9.0	6.0	3.0
Exterior marine paints and enamels	0.750	13.5	11.3	9.0	6.8	4.5	2.3
Exterior paints for metal	0.500	9.0	7.4	6.0	4.5	3.0	1.5
Miscellaneous	0.500	9.0	7.4	6.0	4.5	3.0	1.5
Interior Paints							
Oil and alkyd gloss and quick-drying enamels and tinting bases	0.500	9.0	7.4	6.0	4.5	3.0	1.5
Undercoaters, primers and sealers	0.500	9.0	7.4	6.0	4.5	3.0	1.5
Varnishes, natural and synthetic	2.400	43.2	36.0	28.8	21.6	14.4	7.2
Industrial Products Finishes							
Wrinkle varnish	1.000	18.0	15.0	12.0	9.0	6.0	3.0
Undercoaters and primers	0.750	13.5	11.3	9.0	6.7	4.5	2.3

[1] From Col. 2, Appendix B, Table 13.

[2] Tung oil is assumed to substitute for other ingredients at a 1:1 ratio.

Table 18. Cost of using tung oil alternative ingredients.[1]

Proposed usage of tung oil per gallon of product	Cost per gallon of product of substituting tung oil for other ingredients when tung tung oil costs an additional									
	2c/lb.	4c/lb.	6c/lb.	8c/lb.	10c/lb.	12c/lb.	14c/lb.	16c/lb.	18c/lb.	20c/lb.
(lbs. per gal.)					(cents)					
0.1	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
0.2	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
0.3	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0
0.4	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0
0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.6	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0
0.7	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.0
0.8	1.6	3.2	4.8	6.4	8.0	9.6	11.2	12.8	14.4	16.0
0.9	1.8	3.6	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0
1.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0
1.1	2.2	4.4	6.6	8.8	11.0	13.2	15.4	17.6	19.8	22.0
1.2	2.4	4.8	7.2	9.6	12.0	14.4	16.8	19.2	21.6	24.0
1.3	2.6	5.2	7.8	10.4	13.0	15.6	18.2	20.8	23.4	26.0
1.4	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0
1.5	3.0	6.0	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0
1.6	3.2	6.4	9.6	12.8	16.0	19.2	22.4	25.6	28.8	32.0
1.7	3.4	6.8	10.2	13.6	17.0	20.4	23.8	27.2	30.6	34.0
1.8	3.6	7.2	10.8	14.4	18.0	21.6	25.2	28.8	32.4	36.0
1.9	3.8	7.6	11.4	15.2	19.0	22.8	26.6	30.4	34.2	38.0
2.0	4.0	8.0	12.0	16.0	20.0	24.0	28.0	32.0	36.0	40.0
2.1	4.2	8.4	12.6	16.8	21.0	25.2	29.4	33.6	37.8	42.0
2.2	4.4	8.8	13.2	17.6	22.0	26.4	30.8	35.2	39.6	44.0
2.3	4.6	9.2	13.8	18.4	23.0	27.6	32.2	36.8	41.4	46.0
2.4	4.8	9.6	14.4	19.2	24.0	28.8	33.6	38.4	43.2	48.0
2.5	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
2.6	5.2	10.4	15.6	20.8	26.0	31.2	36.4	41.6	46.8	52.0
2.7	5.4	10.8	16.2	21.6	27.0	32.4	37.8	43.2	48.6	54.0

[1] Tung oil is assumed to substitute for other ingredients at a 1:1 ratio.

The quality attributes of a raw material are ultimately manifested in the value of the finished product. Although the opinions of the respondents regarding the relative merit of tung oil support the hypothesis that it is a superior raw material, objective estimates of the value added to the finished products as a result of using tung oil are not currently available. Consideration should be given to orienting and strengthening the research program, to establish objective measures of the added value of using tung oil. These measures should be developed so that they can be expressed in either physical or monetary terms.

UTILIZATION OF TUNG OIL IN SPECIAL PRODUCTS

The term "special product" as used in this report refers to all products where there is a potential for tung oil usage other than protective coatings. In some years as much as 20 to 30 percent of the tung oil used was in the manufacture of these products (Appendix B, Table 14). The products involved cannot be identified from available statistics. However, it is known that the major products in this category are hardboards, printing inks and brake and clutch linings. For these products, tung oil is often used as either a drying or bonding agent.

In this study primary emphasis was placed on the utilization of tung oil in protective coatings, consequently, the sample did not adequately represent tung oil usage in special products. However, some information was obtained for these products. Although final conclusions cannot be drawn from these data, it may be possible for interested groups to use this information in conjunction with information from other sources as a basis for drawing conclusions. Therefore, this chapter is devoted to a summary of the information for special products obtained from the survey.

No information was obtained for brake and clutch linings. Apparently the survey did not include a plant that used tung oil in the manufacture of this product. Four plants reported the usage of tung oil in the manufacture of inks and two plants reported the usage of tung oil in the manufacture of hardboard during the 1961-64 period. Although there were only a small number of plants reporting the usage of tung oil in special products, these plants used over one and one-half million pounds of tung oil in 1964.

Table 19. Changes in utilization of tung oil in special products from 1961 to 1964.

Product	Reported tung oil consumption 1961	1964	Change from 1961 to 1964
	(thousands	of lbs.	(percent)
Inks	352.6	392.6	11.3
Hardboard	1,545.0	1,230.0	—20.4
Total	1,897.6	1,622.6	—14.5

Source: Survey data.

The utilization of tung oil in inks increased by more than 11 percent during the 1961-64 period (Table 19). Although this increase represented the additional utilization of only 40,000 pounds of tung oil, it indicated that at least some companies either utilized more tung oil per unit of product or increased the production of the types of ink which use tung oil. Utilization of tung oil in hardboard decreased by over 300,000 pounds during the 1961-64 period. This was a 20 percent decrease in tung oil utilization and accounts for the over-all decrease in the utilization of tung oil for special products.

Plants consuming tung oil in special products were asked to estimate the amount of oil they would have consumed during 1964 if they had been assured of adequate supplies and a stabilized price of not over 30 cents per pound. All of the plants completing this part of the questionnaire indicated that the decision to use tung oil would not be affected by a price stabilization program (Table 20).

Table 20. Effect of a supply-price stabilization program on utilization of tung oil in special products, 1964.

	Reported tung oil consumption in 1964[1]		
Product	Actual situation	Stabilized supply and 30c price	Change from actual situation to supply-price stabilization
	(thous. lbs.)		(percent)
Inks	36.0	36.0	0.0
Hardboard	1,230.0	1,230.0	0.0
Total	1,266.0	1,266.0	0.0

Source: Survey data.

[1] Based only on plants completing a questionnaire for both the actual 1964 situation and probable usage under a supply-price stabilization program.

Even though there is little basis for drawing conclusions from this analysis, it appears that tung oil is being replaced in at least some hardboard products. This decrease in consumption is partially offset by an increase in the utilization of tung oil in inks.

SUMMARY AND CONCLUSIONS

The tung industry of the United States is concentrated in the Gulf Coastal Region. The productive life of tung trees normally does not exceed 30 to 40 years and many of the trees are approaching the end of productive life. Tung producers must make the decision to either re-establish and improve orchards or to divert lands to other uses. The future of the tung industry is dependent upon the decisions to be made in the near future. The purpose of this study was to provide the tung industry with needed market information.

The primary use of tung oil is as a raw material for the manufacture of protective coatings. Several types of analysis were considered in this study (1) trends in tung oil utilization, (2) changes in tung oil usage for individual products resulting from raw material substitution and changes in product production, (3) tung oil usage per gallon of product, (4) supply-price stabilization and development programs, (5) added costs of using tung oil and (6) tung oil usage in special products.

Tung oil usage by the Paint, Varnish and Lacquer Industry decreased by over 44 percent during the 1955-64 period. The annual average volume of tung oil purchased per plants in 1955 was 123 thousand pounds compared to 109 thousand pounds in 1964. Changes in the usage of tung oil per gallon of product and changes in the production of specific products were used to evaluate the effect of raw material substitution and changes in product production. From 1961 to 1964, there was a decrease in tung oil consumption of 4.4 million pounds. This was primarily the result of raw material substitution. If raw material subsituation had not occurred, tung oil consumption would have increased by over 3.6 million pounds from 1961 to 1964 because of increases in the production of protective coatings.

The analysis of supply-price stabilization indicated that if tung oil customers had been assured of adequate supplies and stabilized prices not exceeding 30 cents per pound, consumption of tung oil would have been 8.4 percent higher in 1964. This represented an increase of over two million pounds for the year. Proposed formulations provided a measure of the potential usage of tung oil per gallon of product; these ranged from .5 to 2.4 pounds.

Proportions of 1964 production that could have been used on proposed formulations were estimated. These ranged from less than 1 percent for traffic paints to over 55 percent for interior undercoaters, primers and sealers.

The additional cost per gallon of product of using tung oil rather than raw materials was evaluated. The added cost was largest for those products requiring largest amounts of tung oil for any specified price of alternative raw materials.

Appendix B, Table 4. Percentage distribution of tung oil purchases by size of annual purchase, 1955-64.

	Annual Volumes Purchased (thous. lbs.							
Year	Above 0-10	11-25	26-50	51-100	101-250	251-500	Above 500	Total
	(...................... percent	of total	annual	purchases	........................)			
1955	0.3	1.3	5.2	11.5	12.4	11.7	57.6	100.0
1956	0.5	1.6	4.4	11.8	13.7	10.4	57.6	100.0
1957	0.4	1.8	4.2	12.0	11.1	15.1	55.4	100.0
1958	2.6	1.4	2.1	12.1	7.8	16.8	57.2	100.0
1959	0.8	1.0	2.5	12.0	8.9	13.0	61.8	100.0
1960	0.6	0.4	4.9	12.1	6.9	21.3	53.8	100.0
1961	0.5	1.1	3.9	15.1	5.8	20.9	52.7	100.0
1962	0.5	1.3	4.3	14.1	4.9	25.5	49.4	100.0
1963	0.8	2.2	2.5	11.4	17.2	25.6	40.3	100.0
1964	1.1	1.8	3.2	7.3	17.4	25.5	43.7	100.0

Source: Survey data.

Appendix B, Table 5. Number of plants using tung oil and utilization of tung oil, 1955-64.

	Survey results			Estimates for industry		
Year	Number of plants reporting volume purchased[1]	Average volume purshased per plant surveyed	Volume purchased by plants surveyed	Estimated number of plants consuming tung oil[2]	Apparent disappearance of tung oil[3]	Volume purchased by plants surveyed as a percentage of apparent disappearance
	(number)	(thous. lbs.)	(thous. lbs.)	(number)	(thous. lbs.)	(percent)
1955	45	123	5,536	408	50,185	11.0
1956	48	126	6,056	407	51,261	11.8
1957	51	128	6,526	379	48,463	13.5
1958	50	135	6,752	294	39,637	17.0
1959	59	139	8,180	350	48,643	16.8
1960	67	135	9,012	295	39,810	22.6
1961	72	128	9,182	316	40,400	22.7
1962	75	119	8,923	282	33,500	26.6
1963	72	110	7,926	279	30,700	25.8
1964	80	109	8,733	286	31,200	28.0

[1] Note: Trends in plant numbers and volumes purchased which were developed from survey data are opposite to those for the industry because the information provided by the survey was more complete for recent years.

[2] Computed by dividing the apparent disappearance of tung oil by the average volume of tung oil purchases reported by plants surveyed.

[3] **Commodity Year Book - 1965,** Commodity Research Bureau., Inc., N. Y., N. Y., p. 344.

Appendix B, Table 6. Trend in tung oil consumption and product production for specified products..

Product	Estimated tung oil consumption		Av. annual change in tung oil consumption from 1961-64	Estimated product production[3]		Av. annual change in product production from 1958-63
	1961[1]	1964[2]		1958	1963	
	(........	thous. lbs.	........)	(........	thous. of gals.	........)
Exterior Paints						
Oil and alykd paints and tinting bases	1,876.0	1,699.2	—58.9	50,022.0	47,125.0	—579.4
Water emulsion paints and tinting bases	532.0	613.6	27.2	10,350.5	19,899.0	1909.7
Exterior wood primers	784.0	755.2	— 9.6	8,686.0	11,587.0	580.2
Enamels and tinting bases	168.0	236.0	22.7	16,132.0	18,150.0	403.6
Varnishes, natural and synthetic	4,004.0	3,115.2	—296.3	6,073.0	4,521.0	—310.4
Automotive and machinery refinish paints, enamels and primers	420.0	306.8	—37.7	NA	NA	NA
Traffic paints	84.0	70.8	— 4.4	6,317.0	9,070.0	550.6
Exterior marine paints and enamels	420.0	519.2	33.1	1,978.0	2,739.0	152.2
Exterior paints for metal	644.0	283.2	—120.3	NA	NA	NA
Miscellaneous	364.0	377.6	4.5	NA	NA	NA
Interior Paints						
Oil and alykd flat wall paints and tinting bases	*	0.0	*	27,494.0	23,049.0	—899.0
Oil and alykd semi-gloss paints and tinting bases	84.0	0.0	—28.0	29,087.0	34,646.0	1,111.8
Oil and alykd gloss and quick-drying enamels and tinting bases	812.0	873.2	20.4			
Water emulsion paints and tinting bases	504.0	590.0	28.7	49,690.0	78,519.0	5,765.8
Undercoaters, primers and sealers	2,100.0	2,171.2	23.7	6,769.0	7,650.0	176.2
Varnish, natural and synthetic	4,088.0	3,776.0	—104.0	5,840.0	9,362.0	704.4
Interior marine paints and enamels	28.0	70.8	14.3	NA	NA	NA
Miscellaneous	0.0	0.0	0.0	NA	NA	NA
Industrial Product Finishes						
Wood furniture and fixtures	280.0	354.0	24.7	NA	7,507.0	NA
Metal furniture and fixtures	*	0.0	*	NA	NA	NA
Sheet, strips and coil coatings	*	0.0	*	NA	7,989.0	NA
Appliances	*	0.0	*	6,635.0	9,957.0	664.4
Automotive	672.0	424.8	—82.4	19,146.0	27,501.0	1,671.0
Railroads	*	0.0	*	NA	NA	NA
Toys, sporting goods, gym and baby equipment	56.0	23.6	—10.8	NA	NA	NA
Machinery and equipment	168.0	70.8	—32.4	NA	12,474.0	NA
Insulating varnish	5,572.0	4,979.6	—197.5	2,992.0	5,615.3**	524.7
Can coatings	1,064.0	495.6	—189.5	NA	NA	NA
Wrinkle varnish***	0.0	70.8	23.6	13,004.0	5,992.0	—1,402.4
Undercoaters and primers	3,108.0	1,486.8	—540.4	18,024.0	25,980.0	1,591.2
Miscellaneous	112.0	165.2	17.7	NA	NA	NA
Miscellaneous Products	56.0	70.8	4.9	NA	NA	NA

[1] From Col. 2, Appendix B. Table 10.

[2] From Col. 2, Appendix B, Table 9.

[3] Production data were obtained from Preliminary Report, Paints and Allied Products Industry Series, **1963 Census of Manufactures,** except as noted.

*There were no respondents for 1961.

Production estimate for 1963 was based on a constant price from 1958 to 1963 and changes in value of production as reported by Preliminary Report, Paints and Allied Products Industry Series, **1963 Census of Manufacturers.

***Since wrinkle varnish was not clearly identified on the questionnaire, estimated tung oil consumption was considered to be a low estimate.

Appendix B, Table 7. Percentage of plants reporting usage of tung oil by classes of product.

Product	Year		
	1961	1964	1964[1]
		(percent of plants)	
Exterior Paints			
Oil and alkyd house paints and tinting bases	10.2	9.3	14.3
Water emulsion paints and tinting bases	10.2	9.3	8.6
Exterior wood primers	8.2	5.6	5.7
Enamels and tinting bases	8.2	7.4	8.6
Varnishes, natural and synthetic	38.8	33.3	37.1
Automotive and machinery refinish paints, enamels ad primers	4.1	5.6	5.7
Traffic paints	6.1	5.6	2.9
Exterior marine paints and enamels	14.3	14.8	17.1
Exterior paints for metal	16.3	18.5	17.1
Miscellaneous	2.0	3.7	2.9
Total for Exterior Paints	57.1	59.3	57.1
Interior Paints			
Oil and alkyd flat wall paints and tinting bases	*	*	*
Oil and alkyd semi-gloss paints and tinting bases	2.0	0.0	0.0
Oil and alkyd gloss and quick-drying enamels and tinting bases	10.2	9.3	8.6
Water emulsion paints and tinting bases	4.1	3.7	5.7
Undercoaters, primers and sealers	10.2	9.3	11.4
Varnishes, natural and synthetic	20.4	18.5	20.0
Interior marine paints and enamels	2.0	3.7	0.0
Miscellaneous	4.1	3.7	5.7
Total for Interior Paints	36.7	33.3	37.1
Industrial Product Finishes			
Wood furniture and fixtures	8.2	5.6	8.6
Metal furniture and fixtures	*	*	*
Sheet, strip and coil coatings	*	*	*
Appliances	*	*	*
Automotive	2.0	1.9	2.9
Railroads	*	*	*
Toys, sporting goods, gym and baby equipment	2.0	1.9	2.9
Machinery and equipment	8.2	7.4	8.6
Insulating varnish	10.2	9.3	11.4
Can coatings	8.2	7.4	5.7
Wrinkle varnish**	*	1.9	*
Undercoaters and primers	2.0	1.9	*
Miscellaneous	4.1	5.6	5.7
Total for Industrial Product Finishes	38.8	40.7	40.0
Special Products			
Brake and clutch linings	*	*	*
Inks	8.2	7.4	2.9
Hardboard	4.1	3.7	5.7
Total for Special Products	12.2	11.1	8.6
Miscellaneous Products	2.0	1.9	2.9
Total number of plants reporting usage of tung oil by product	49	54	35

Sources: Survey data.

[1] Percentage of plants that would have used tung oil in each product in 1964, if they had been assured of adequate supplies and stabilized prices of not over 30 cents per pound for several years.

*There were no respondents to these questions.

**Since wrinkle varnish was not clearly identified on the questionnaire, reported tung oil utilization for this product was considered to be understated.

Appendix B, Table 8. **Percentage of reported tung oil used in specified products in 1961 and 1964 and approximate percentages of tung oil that would have been used in products if there had been an effective price stabilization program in 1964.**

Product	Year		
	1961	1964 (percent of oil)	1964[1]
Exterior Paints			
Oil and alkyd paints and tinting bases	4.6	4.9	8.3
Water emulsion paints and tinting bases	1.3	1.8	1.6
Exterior wood primers	1.9	2.2	3.0
Enamels and tinting bases	0.4	0.7	0.7
Varnishes, natural and synthetic	9.8	9.0	10.7
Automotive and machinery refinish paints, enamels, and primers	1.0	0.9	1.2
Traffic Paints	0.2	0.2	0.1
Exterior marine paints and enamels	1.0	1.5	0.7
Exterior paints for metal	1.6	0.8	0.4
Miscellaneous	0.9	1.1	0.1
Total for Exterior Paints	22.7	23.1	26.8
Interior Paints			
Oil and alkyd flat wall paints and tinting bases	*	*	*
Oil and alkyd semi-gloss paints and tinting bases	0.2	0.0	0.0
Oil and alkyd gloss and quick-drying enamels and tinting bases	2.0	2.5	3.1
Water emulsion paints and tinting bases	1.2	1.7	2.5
Undercoaters, primers and sealers	5.1	6.3	8.8
Varnishes, natural and synthetic	10.0	10.9	3.9
Interior marine paints and enamels	0.1	0.2	*
Miscellaneous	0.0	0.0	0.1
Total for Interior Paints	18.6	21.6	18.4
Industrial Product Finishes			
Wood furniture and fixtures	0.7	1.0	1.7
Metal furniture and fixtures	*	*	*
Sheet, strip and coil coatings	*	*	*
Appliances	*	*	*
Automotive	1.6	1.2	1.8
Railroads	*	*	*
Toys, sporting goods, gym and baby equipment	0.1	0.1	0.2
Machinery and Equipment	0.4	0.2	0.1
Insulating varnish	13.6	14.4	12.5
Can coatings	2.6	1.4	0.2
Wrinkle varnishes**	0.0	0.2	*
Undercoaters and primers	7.6	4.3	*
Miscellaneous	0.3	0.5	0.5
Total for Industrial Product finishes	26.9	23.3	17.0
Special Products			
Brake and clutch linings	*	*	*
Inks	5.9	7.7	1.1
Hardboard	25.8	24.1	36.4
Total for Special Products	31.7	31.8	37.5
Miscellaneous products	0.1	0.2	0.3
Total volume reported (thousands of pounds)	5,983	5,106	3,383

Source: Survey data.

[1] Approximate percentage of tung oil that would have been used in each product in 1964, if plants had been assured of adequate supplies and stabilized prices of not over 30 cents per pound for several years.

*There were no respondents to these questions.

**Since wrinkle varnish was not clearly identified on the questionnaire, reported tung oil utilization was considered to be understated.

Appendix B, Table 4. Percentage distribution of tung oil purchases by size of annual purchase, 1955-64.

	Annual Volumes Purchased (thous. lbs.							
Year	Above 0-10	11-25	26-50	51-100	101-250	251-500	Above 500	Total
	(........................ percent of total annual purchases ....)							
1955	0.3	1.3	5.2	11.5	12.4	11.7	57.6	100.0
1956	0.5	1.6	4.4	11.8	13.7	10.4	57.6	100.0
1957	0.4	1.8	4.2	12.0	11.1	15.1	55.4	100.0
1958	2.6	1.4	2.1	12.1	7.8	16.8	57.2	100.0
1959	0.8	1.0	2.5	12.0	8.9	13.0	61.8	100.0
1960	0.6	0.4	4.9	12.1	6.9	21.3	53.8	100.0
1961	0.5	1.1	3.9	15.1	5.8	20.9	52.7	100.0
1962	0.5	1.3	4.3	14.1	4.9	25.5	49.4	100.0
1963	0.8	2.2	2.5	11.4	17.2	25.6	40.3	100.0
1964	1.1	1.8	3.2	7.3	17.4	25.5	43.7	100.0

Source: Survey data.

Appendix B, Table 5. Number of plants using tung oil and utilization of tung oil, 1955-64.

	Survey results			Estimates for industry		
Year	Number of plants reporting volume purchased[1]	Average volume purshased per plant surveyed	Volume purchased by plants surveyed	Estimated number of plants consuming tung oil[2]	Apparent disappearance of tung oil[3]	Volume purchased by plants surveyed as a percentage of apparent disappearance
	(number)	(thous. lbs.)	(thous. lbs.)	(number)	(thous. lbs.)	(percent)
1955	45	123	5,536	408	50,185	11.0
1956	48	126	6,056	407	51,261	11.8
1957	51	128	6,526	379	48,463	13.5
1958	50	135	6,752	294	39,637	17.0
1959	59	139	8,180	350	48,643	16.8
1960	67	135	9,012	295	39,810	22.6
1961	72	128	9,182	316	40,400	22.7
1962	75	119	8,923	282	33,500	26.6
1963	72	110	7,926	279	30,700	25.8
1964	80	109	8,733	286	31,200	28.0

[1] Note: Trends in plant numbers and volumes purchased which were developed from survey data are opposite to those for the industry because the information provided by the survey was more complete for recent years.

[2] Computed by dividing the apparent disappearance of tung oil by the average volume of tung oil purchases reported by plants surveyed.

[3] **Commodity Year Book - 1965,** Commodity Research Bureau., Inc., N. Y., N. Y., p. 344.

Appendix B, Table 6. Trend in tung oil consumption and product production for specified products.

Product	Estimated tung oil consumption 1961[1]	Estimated tung oil consumption 1964[2]	Av. annual change in tung oil consumption from 1961-64	Estimated product production[3] 1958	Estimated product production[3] 1963	Av. annual change in product production from 1958-63
	(........	thous. lbs.	........)	(........	thous. of gals.	........)
Exterior Paints						
Oil and alykd paints and tinting bases	1,876.0	1,699.2	—58.9	50,022.0	47,125.0	—579.4
Water emulsion paints and tinting bases	532.0	613.6	27.2	10,350.5	19,899.0	1909.7
Exterior wood primers	784.0	755.2	— 9.6	8,686.0	11,587.0	580.2
Enamels and tinting bases	168.0	236.0	22.7	16,132.0	18,150.0	403.6
Varnishes, natural and synthetic	4,004.0	3,115.2	—296.3	6,073.0	4,521.0	—310.4
Automotive and machinery refinish paints, enamels and primers	420.0	306.8	—37.7	NA	NA	NA
Traffic paints	84.0	70.8	— 4.4	6,317.0	9,070.0	550.6
Exterior marine paints and enamels	420.0	519.2	33.1	1,978.0	2,739.0	152.2
Exterior paints for metal	644.0	283.2	—120.3	NA	NA	NA
Miscellaneous	364.0	377.6	4.5	NA	NA	NA
Interior Paints						
Oil and alykd flat wall paints and tinting bases	*	0.0	*	27,494.0	23,049.0	—899.0
Oil and alykd semi-gloss paints and tinting bases	84.0	0.0	—28.0	29,087.0	34,646.0	1,111.8
Oil and alykd gloss and quick-drying enamels and tinting bases	812.0	873.2	20.4			
Water emulsion paints and tinting bases	504.0	590.0	28.7	49,690.0	78,519.0	5,765.8
Undercoaters, primers and sealers	2,100.0	2,171.2	23.7	6,769.0	7,650.0	176.2
Varnish, natural and synthetic	4,088.0	3,776.0	—104.0	5,840.0	9,362.0	704.4
Interior marine paints and enamels	28.0	70.8	14.3	NA	NA	NA
Miscellaneous	0.0	0.0	0.0	NA	NA	NA
Industrial Product Finishes						
Wood furniture and fixtures	280.0	354.0	24.7	NA	7,507.0	NA
Metal furniture and fixtures	*	0.0	*	NA	NA	NA
Sheet, strips and coil coatings	*	0.0	*	NA	7,989.0	NA
Appliances	*	0.0	*	6,635.0	9,957.0	664.4
Automotive	672.0	424.8	—82.4	19,146.0	27,501.0	1,671.0
Railroads	*	0.0	*	NA	NA	NA
Toys, sporting goods, gym and baby equipment	56.0	23.6	—10.8	NA	NA	NA
Machinery and equipment	168.0	70.8	—32.4	NA	12,474.0	NA
Insulating varnish	5,572.0	4,979.6	—197.5	2,992.0	5,615.3**	524.7
Can coatings	1,064.0	495.6	—189.5	NA	NA	NA
Wrinkle varnish***	0.0	70.8	23.6	13,004.0	5,992.0	—1,402.4
Undercoaters and primers	3,108.0	1,486.8	—540.4	18,024.0	25,980.0	1,591.2
Miscellaneous	112.0	165.2	17.7	NA	NA	NA
Miscellaneous Products	56.0	70.8	4.9	NA	NA	NA

[1] From Col. 2, Appendix B. Table 10.

[2] From Col. 2, Appendix B, Table 9.

[3] Production data were obtained from Preliminary Report, Paints and Allied Products Industry Series, **1963 Census of Manufactures,** except as noted.

*There were no respondents for 1961.

Production estimate for 1963 was based on a constant price from 1958 to 1963 and changes in value of production as reported by Preliminary Report, Paints and Allied Products Industry Series, **1963 Census of Manufacturers.

***Since wrinkle varnish was not clearly identified on the questionnaire, estimated tung oil consumption was considered to be a low estimate.

Appendix B, Table 7. Percentage of plants reporting usage of tung oil by classes of product.

Product	Year		
	1961	1964	1964[1]
		(percent of plants)	
Exterior Paints			
Oil and alkyd house paints and tinting bases	10.2	9.3	14.3
Water emulsion paints and tinting bases	10.2	9.3	8.6
Exterior wood primers	8.2	5.6	5.7
Enamels and tinting bases	8.2	7.4	8.6
Varnishes, natural and synthetic	38.8	33.3	37.1
Automotive and machinery refinish paints, enamels ad primers	4.1	5.6	5.7
Traffic paints	6.1	5.6	2.9
Exterior marine paints and enamels	14.3	14.8	17.1
Exterior paints for metal	16.3	18.5	17.1
Miscellaneous	2.0	3.7	2.9
Total for Exterior Paints	57.1	59.3	57.1
Interior Paints			
Oil and alkyd flat wall paints and tinting bases	*	*	*
Oil and alkyd semi-gloss paints and tinting bases	2.0	0.0	0.0
Oil and alkyd gloss and quick-drying enamels and tinting bases	10.2	9.3	8.6
Water emulsion paints and tinting bases	4.1	3.7	5.7
Undercoaters, primers and sealers	10.2	9.3	11.4
Varnishes, natural and synthetic	20.4	18.5	20.0
Interior marine paints and enamels	2.0	3.7	0.0
Miscellaneous	4.1	3.7	5.7
Total for Interior Paints	36.7	33.3	37.1
Industrial Product Finishes			
Wood furniture and fixtures	8.2	5.6	8.6
Metal furniture and fixtures	*	*	*
Sheet, strip and coil coatings	*	*	*
Appliances	*	*	*
Automotive	2.0	1.9	2.9
Railroads	*	*	*
Toys, sporting goods, gym and baby equipment	2.0	1.9	2.9
Machinery and equipment	8.2	7.4	8.6
Insulating varnish	10.2	9.3	11.4
Can coatings	8.2	7.4	5.7
Wrinkle varnish**	*	1.9	*
Undercoaters and primers	2.0	1.9	*
Miscellaneous	4.1	5.6	5.7
Total for Industrial Product Finishes	38.8	40.7	40.0
Special Products			
Brake and clutch linings	*	*	*
Inks	8.2	7.4	2.9
Hardboard	4.1	3.7	5.7
Total for Special Products	12.2	11.1	8.6
Miscellaneous Products	2.0	1.9	2.9
Total number of plants reporting usage of tung oil by product	49	54	35

Sources: Survey data.

[1] Percentage of plants that would have used tung oil in each product in 1964, if they had been assured of adequate supplies and stabilized prices of not over 30 cents per pound for several years.

*There were no respondents to these questions.

**Since wrinkle varnish was not clearly identified on the questionnaire, reported tung oil utilization for this product was considered to be understated.

Appendix B, Table 8. **Percentage of reported tung oil used in specified products in 1961 and 1964 and approximate percentages of tung oil that would have been used in products if there had been an effective price stabilization program in 1964.**

Product	Year		
	1961	1964 (percent of oil)	1964[1]
Exterior Paints			
Oil and alkyd paints and tinting bases	4.6	4.9	8.3
Water emulsion paints and tinting bases	1.3	1.8	1.6
Exterior wood primers	1.9	2.2	3.0
Enamels and tinting bases	0.4	0.7	0.7
Varnishes, natural and synthetic	9.8	9.0	10.7
Automotive and machinery refinish paints, enamels, and primers	1.0	0.9	1.2
Traffic Paints	0.2	0.2	0.1
Exterior marine paints and enamels	1.0	1.5	0.7
Exterior paints for metal	1.6	0.8	0.4
Miscellaneous	0.9	1.1	0.1
Total for Exterior Paints	22.7	23.1	26.8
Interior Paints			
Oil and alkyd flat wall paints and tinting bases	*	*	*
Oil and alkyd semi-gloss paints and tinting bases	0.2	0.0	0.0
Oil and alkyd gloss and quick-drying enamels and tinting bases	2.0	2.5	3.1
Water emulsion paints and tinting bases	1.2	1.7	2.5
Undercoaters, primers and sealers	5.1	6.3	8.8
Varnishes, natural and synthetic	10.0	10.9	3.9
Interior marine paints and enamels	0.1	0.2	*
Miscellaneous	0.0	0.0	0.1
Total for Interior Paints	18.6	21.6	18.4
Industrial Product Finishes			
Wood furniture and fixtures	0.7	1.0	1.7
Metal furniture and fixtures	*	*	*
Sheet, strip and coil coatings	*	*	*
Appliances	*	*	*
Automotive	1.6	1.2	1.8
Railroads	*	*	*
Toys, sporting goods, gym and baby equipment	0.1	0.1	0.2
Machinery and Equipment	0.4	0.2	0.1
Insulating varnish	13.6	14.4	12.5
Can coatings	2.6	1.4	0.2
Wrinkle varnishes**	0.0	0.2	*
Undercoaters and primers	7.6	4.3	*
Miscellaneous	0.3	0.5	0.5
Total for Industrial Product finishes	26.9	23.3	17.0
Special Products			
Brake and clutch linings	*	*	*
Inks	5.9	7.7	1.1
Hardboard	25.8	24.1	36.4
Total for Special Products	31.7	31.8	37.5
Miscellaneous products	0.1	0.2	0.3
Total volume reported (thousands of pounds)	5,983	5,106	3,383

Source: Survey data.

[1] Approximate percentage of tung oil that would have been used in each product in 1964, if plants had been assured of adequate supplies and stabilized prices of not over 30 cents per pound for several years.

*There were no respondents to these questions.

**Since wrinkle varnish was not clearly identified on the questionnaire, reported tung oil utilization was considered to be understated.

Appendix B, Table 9 **Utilization of tung oil in specified products by the Protective Coatings Industry, 1964.**

Product	Percent of tung oil used[1]	Estimated tung oil consumption[2]
	(percent)	(thous. lbs.)
Exterior Paints		
Oil and alkyd house paints and tinting bases	7.2	1,699.2
Water emulsion paints and tinting bases	2.6	613.6
Exterior wood primers	3.2	755.2
Enamels and tinting bases	1.0	236.0
Varnishes, natural and synthetic	13.2	3,115.2
Automotive and machinery refinish paints, enamels and primers	1.3	306.8
Traffic paints	0.3	70.8
Exterior marine paints and enamels	2.2	519.2
Exterior paints for metal	1.2	283.2
Miscellaneous	1.6	377.6
Interior Paints		
Oil and alkyd flat wall paints and tinting bases	0.0	0.0
Oil and alkyd semi-gloss paints and tinting bases	0.0	0.0
Oil and alkyd gloss and quick-drying enamels and tinting bases	3.7	873.2
Water emulsion paints and tinting bases	2.5	590.0
Undercoaters, primers and sealers	9.2	2,171.2
Varnishes, natural and synthetic	16.0	3,776.0
Interior marine paints and enamels	0.3	70.8
Miscellaneous	0.0	0.0
Industrial Product Finishes		
Wood furniture and fixtures	1.5	354.0
Metal furniture and fixtures	0.0	0.0
Sheet, strip and coil coatings	0.0	0.0
Appliances	0.0	0.0
Automotive	1.8	424.8
Railroads	0.0	0.0
Toys, sporting goods, gym and baby equipment	0.1	23.6
Machinery and equipment	0.3	70.8
Insulating varnish	21.1	4,979.6
Can coatings	2.1	495.6
Wrinkle varnish*	0.3	70.8
Undercoaters and primers	6.3	1,486.8
Miscellaneous	0.7	165.2
Miscellaneous Products	0.3	70.8
Total	100.0	23,600.0

[1] Percentage from Col. 2 Appendix B, Table 8, adjusted to 100 percent after deletion of Special Products.

[2] Estimated by applying percentages in Col. 1 to 23.6 million pounds, the 1964 factory consumption of tung oil by the Paint and Varnish Industry, as quoted in **Commodity 1965 Rearbook.** p. 344.

*Since wrinkle varnish was not clearly identified on the questionnaire, reported utilization of tung oil was considered to be understated.

Appendix B, Table 10. Utilization of tung oil in specified products by the Protective Coatings Industry, 1961.

Product	Percent of tung oil used[1]	Estimated tung oil consumption[2]
	(percent)	(thous. lbs.)
Exterior Paints		
Oil and alkyd house paints and tinting bases	6.7	1,876.0
Water emulsion paints and tinting bases	1.9	532.0
Exterior wood primers	2.8	784.0
Enamels and tinting bases	0.6	168.0
Varnishes, natural and synthetic	14.3	4,004.0
Automotive and machinery refinish paints, enamels and primers	1.5	420.0
Traffic paints	0.3	84.0
Exterior marine paints and enamels	1.5	420.0
Exterior paints for metal	2.3	644.0
Miscellaneous	1.3	364.0
Interior paints		
Oil and alkyd flat paints and tinting bases	*	*
Oil and alkyd semi-gloss paints and tinting bases	0.3	84.0
Oil and alkyd gloss and quick-drying enamels and tinting bases	2.9	812.0
Water emulsion paints and tinting bases	1.8	504.0
Undercoaters, primers and sealers	7.5	2,100.0
Varnishes, natural and synthetic	14.6	4,088.0
Interior marine paints and enamels	0.1	28.0
Miscellaneous	0.0	0.0
Industrial Product Finishes		
Wood furniture and fixtures	1.0	280.0
Metal furniture and fixtures	*	*
Sheet, strip and coil coatings	*	*
Appliances	*	*
Automotive	2.4	672.0
Railroads	*	*
Toys, sporting goods, gym and baby equipment	0.2	56.0
Machinery and equipment	0.6	168.0
Insulating varnish	19.9	5,572.0
Can coatings	3.8	1,064.0
Wrinkle varnish**	0.0	0.0
Undercoaters and primers	11.1	3,108.0
Miscellaneous	0.4	56.0
Miscellaneous Products	0.2	28,000.0
Total	100.0	

[1] Percentages from Col. 1, Appendix B, Table 8, adjusted to 100 percent after deletion of Special Products.

[2] Estimated by applying percentages in Col. 1 to 28.0 million pounds the 1961 factory consumption of tung oil by the Paint and Varnish Industry, as quoted in **Commodity 1965 Yearbook.** p. 344.

*There were no respondents for these products.

**Since wrinkle varnish was not clearly identified on the questionnaire, reported utilization of tung oil was considered to be understated.

Appendix B, Table 11. **Tung oil utilization per gallon of product for total U.S. production of specified products, 1961.**

Product	Estimated product production[1]	Estimated tung oil consumption[2]	Estimated usage of tung oil per gallon of product
	(thous. gal.)	(thous. lbs.)	(lbs. per gal.
Exterior Paints			
Oil and alkyd house paints and tinting bases	48,283.8	1,876.0	0.039
Water emulsion paints and tinting bases	16,079.6	532.0	0.033
Exterior wood primers	10,426.6	784.0	0.075
Enamels and tinting bases	17,342.8	168.0	0.010
Varnishes, natural and synthetic	5,141.8	4,004.0	0.779
Automotive and machinery refinish paints, enamels and primers	67,108.0*	420.0	0.006
Traffic paints	7,968.8	84.0	0.011
Exterior marine paints and enamels	2,434.6	420.0	0.173
Exterior paints for metal	NA	644.0	NA
Miscellaneous	NA	364.0	NA
Interior Paints			
Oil and alkyd flat wall paints and tinting bases	24,827.0	NA	NA
Oil and alkyd semi-gloss paints and tinting bases Oil and alkyd gloss and quick-drying enamels and tinting bases	32,422.4	896.0	0.028
Water emulsion paints and tinting bases	66,987.4	504.0	0.008
Undercoaters, primers and sealers	7,297.6	2,100.0	0.288
Varnishes, natural and synthetic	7,953.2	4,088.0	0.514
Interior marine paints and enamels	372.7*	28.0	0.075
Miscellaneous	NA	0.0	0.000
Industrial Product Finishes			
Wood furniture and fixtures	NA	280.0	NA
Metal furniture and fixtures	17,596.7*	NA	NA
Sheet, strip and coil coatings	NA	NA	NA
Appliances	8,628.2	NA	NA
Automotive	24,159.0	672.0	0.028
Railroads	9,557.7	NA	NA
Toys, sporting goods, gym and baby equipment	3,603.2*	56.0	0.016
Machinery and equipment	NA	168.0	NA
Insulating varnish	4,566.1	5,572.0	1.220
Can Coatings	NA	1,064.0	NA
Wrinkle varnish**	8,796.8	0.0	0.000
Undercoaters and primers	22,797.6	3,108.0	0.136
Miscellaneous	NA	112.0	NA
Miscellaneous Products	NA	56.0	NA

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[1] Extrapolations to 1961 were based on annual changes from 1958-1963 from Appendix B, Table 6, except as noted.

[2] From Col. 2, Appendix B, Table 10.

*Extrapolations to 1961 were based on annual changes from 1963-64 which were developed from the National Paint, Varnish and Lacquer Association's **Annual Sales Surveys for 1963 and 1964.** These estimates are based on broad categories which may have resulted in either overstating or understating estimates for individual product lines.

**Since wrinkle varnish was not clearly identified on the questionnaire, reported utilization of tung oil was considered to be understated.

Appendix B, Table 12. Tung oil utilization per gallon of product for total U.S. production of specified products, 1964.

Product	Estimated product production[1]	Estimated tung oil consumption[2]	Estimated usage of tung oil per gallon of product
	(thous. gals.)	(thous. lbs.)	(lbs. per gal.)
Exterior Paints			
Oil and alkyd house paints and tinting bases	46,545.6	1,699.2	0.037
Water emulsion paints and tinting bases	21,808.7	613.6	0.028
Exterior wood primers	12,167.2	755.2	0.062
Enamels and tinting bases	18,553.6	236.0	0.013
Varnishes, natural and synthetic	4,210.6	3,115.2	0.740
Automotive and machinery refinish paints, enamels and primers	37,957.0*	306.8	0.008
Traffic paints	9,620.6	70.8	0.007
Exterior marine paints and enamels	2,891.2	519.2	0.180
Exterior paints for metal	NA	283.2	NA
Miscellaneous	NA	377.6	NA
Interior Paints			
Oil and alkyd flat wall paints and tinting bases	22,160.0	0.0	0.000
Oil and alkyd semi-gloss paints and tinting bases	35,757.8	873.2	0.024
Oil and alkyd gloss and quick-drying enamels and tinting bases			
Water emulsion paints and tinting bases	84,284.8	590.0	0.007
Undercoaters, primers and sealers	7,826.2	2,171.2	0.277
Varnishes, natural and synthetic	10,066.4	3,776.0	0.375
Interior marine paints and enamels	310.0*	70.8	0.228
Miscellaneous	NA	0.0	0.000
Industrial Product Finishes			
Wood furniture and fixtures	7,507.0**	354.0	0.047
Metal furniture and fixtures	13,717.1*	0.0	0.000
Sheet, strip and coil coatings	7,989.0**	0.0	0.000
Appliances	10,621.4	0.0	0.000
Automotive	29,172.0	424.8	0.015
Railroads	8,601.6*	0.0	0.000
Toys, sporting goods, gym, and baby equipment	2,015.9*	23.6	0.012
Machinery and equipment	12,474.0**	70.8	0.006
Insulating varnish	6,140.0	4,979.6	0.811
Can coatings	NA	495.6	NA
Wrinkle varnish***	4,589.6	70.8	0.015
Undercoaters and primers	27,571.2	1,486.8	0.054
Miscellaneous	NA	165.2	NA
Miscellaneous Products	NA	70.8	NA

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[1] Extrapolations to 1964 were based on annual changes from 1958-1963 from Appendix B, Table 6, except as noted.

[2] From Col. 2, Appendix B, Table 9.

*Data for products not available from the census were developed from the National Paint, Varnish and Lacquer Association's **Annual Sales Survey for 1964.** These estimates are based on broad categories which may have resulted in either overstating or understating estimates for individual product lines.

**Estimates for 1963 production were used since there was no bases to extrapolate to 1964.

***Since wrinkle varnish was not clearly identified on the questionnaire, reported tung oil utilization was considered to be understated.

Appendix B, Table 13. Estimated U.S. production of specified coatings and potential tung oil utilization based on proposed formulations, 1964.

Product	Estimated product production[1]	Proposed usage of tung oil per gallon of product[2]	Total Proposed tung oil utilization
	(thous. gals.)	(lbs. per gal.)	(thous. lbs.)
Exterior Paints			
Oil and alkyd house paints and tinting bases	46,545.6	0.600	27,927.4
Water emulsion paints and tinting bases	21,808.7	0.500	10,904.3
Exterior wood primers	12,167.2	0.600	7,300.3
Enamels and tinting bases	18,553.6	0.500	9,276.8
Varnishes, natural and synthetic	4,210.6	2.000	8,421.2
Automotive and machinery refinish paints, enamels and primers	37,957.0	0.500	18,978.5
Traffic paints	9,620.6	1.000	9,620.6
Exterior marine paints and enamels	2,891.2	0.750	2,168.4
Exterior paints for metal	NA	0.500	283.2
Miscellaneous	NA	0.500	377.6
Interior Paints			
Oil and alkyd flat wall points and tinting bases	22,160.0	0.000*	0.0
Oil and alkyd semi-gloss paints and tinting bases	35,757.8	0.024*	873.2
Oil and alkyd gloss and quick-drying enamels and tinting bases			
Water emulsion paints and tinting bases	84,284.8	0.007*	590.0
Undercoaters, primers and sealers	7,826.2	0.500	3,913.1
Varnishes, natural and synthetic	10,066.4	2.400	24,159.4
Interior marine paints and enamels	310.0	0.228*	70.8
Miscellaneous	NA	0.000*	0.0
Industrial Product Finishes			
Wood furniture and fixtures	7,507.0	0.047*	354.0
Metal furniture and fixtures	13,717.1	0.000*	0.0
Sheet, strip and coil coatings	7,989.0	0.000*	0.0
Appliances	10,621.4	0.000*	0.0
Automotive	29,172.0	0.015*	424.8
Railroads	8,601.6	0.000*	0.0
Toys, sporting goods, gym and baby equipment	2,015.9	0.012*	23.6
Machinery and equipment	12,474.0	0.006*	70.8
Insulating varnish	6,140.0	0.811*	4,979.6
Can coatings	NA	NA	495.6
Wrinkle varnish	4,589.6	1.000	4,589.6
Undercoaters and primers	27,571.2	0.750	20,678.4
Miscellaneous	NA	NA	165.2
Miscellaneous Products	NA	NA	70.8
Total			156,717.2

[1] From Col. 1, Appendix B, Table 12.

[2] Based on proposed formulation of protective coatings products by chemists of the Pan American Tung Research and Development League, except as noted.

*Proposed formulations not available. Data obtained by dividing Col. 3 by Col.-1.

Appendix B, Table 14. Price and consumption of tung oil in the United States, 1955-64.

Year	Price per pound[1] tanks f.o.b. mills	Factory consumption Total[2]	Paint and varnish[2]
	(cents)	(thous. lbs.)	
1955	23.3	49,998	42,636
1956	24.4	48,097	43,689
1957	22.7	43,046	39,676
1958	21.4	37,909	31,805
1959	21.9	41,000	31,500
1960	21.9	38,900	29,600
1961	26.5	37,800	28,000
1962	35.2	34,700	25,200
1963	38.0	32,100[3]	22,500[3]
1964	26.7	33,400[3]	23,600[3]

[1] Source: **Fat and oils situation,** November 1965 and earlier, year beginning November preceding year.

[2] Source: **Commodity Yearbook 1965,** commodity Research Bureau, Inc., N.Y., N.Y., P. 344.

[3] Preliminary.

Appendix B, Table 15. Use of tung oil reported for 1964 and effects of supply-price stabilization program on utilization by product.

Product	Use of tung oil in 1964 by all plants reporting[1]	Use of tung oil reported by selected plants in 1964[2]		Change from actual situation to supply-price stabilization program
		Actual situation	Stabilized supply and 30c price	
	(percent)	(thous. lbs.)		(percent)
Exterior Paints				
Oil and alkyd paints and tinting bases	4.9	249.9	281.1	12.5
Water emulsion paints and tinting bases	1.8	54.4	54.4	0.0
Exterior wood primers	2.2	100.0	101.1	1.1
Enamels and tinting bases	0.7	25.1	25.1	0.0
Varnishes, natural and synthetic	9.0	307.3	360.9	17.4
Automotive and machinery refinish paints, enamels and primers	0.9	24.2	39.8	64.5
Traffic paints	0.2	2.5	5.0	100.0
Exterior marine paints and enamels	1.5	22.9	24.6	7.4
Exterior paints for metal	0.8	6.9	9.4	36.2
Miscellaneous	1.1	1.6	1.6	0.0
Interior Paints				
Oil and alkyd flat wall paints and tinting bases	*	*	*	*
Oil and alkyd semi-gloss paints and tinting bases	0.0	0.0	0.0	0.0
Oil and alkyd gloss and quick-drying enamels and tinting bases	2.5	85.8	106.4	24.0
Water emulsion paints and tinting bases	1.7	86.0	86.0	0.0
Undercoaters, primers and sealers	6.3	321.5	298.1	—7.3
Varnishes, natural and synthetic	10.9	105.1	131.5	25.1
Interior marine paints and enamels	0.2	*	*	*
Miscellaneous	0.0	1.3	1.3	0.0
Industrial Product Finishes				
Wood furniture and fixtures	1.0	52.7	57.1	8.3
Metal furniture and fixtures	*	*	*	*
Sheet, strip and coil coatings	*	*	*	*
Appliances	*	*	*	*
Automotive	1.2	62.4	62.4	0.0
Railroads	*	*	*	*
Toys, sporting goods, gym and baby equipment	0.1	5.0	8.0	60.0
Machinery and equipment	0.2	2.5	2.5	0.0
Insulating varnish	14.4	410.3	422.9	3.1
Can coatings	1.4	21.6	6.6	—69.4
Wrinkle varnish**	0.2	*	*	*
Undercoaters and primers	4.3	*	*	*
Miscellaneous	0.5	17.8	17.8	0.0
Special Products				
Brake and clutch linings	*	*	*	*
Inks	7.7	36.0	36.0	0.0
Hardboard	24.1	1230.0	1230.0	0.0
Miscellaneous Products	0.2	9.7	9.7	0.0

[1] Based on 54 plants reporting use of tung oil by product for 1964.

[2] Based on 36 plants completing a questionnaire for both the actual 1964 situation and probable usage under a supply-price stabilization program.

*No response to questionnaire.

** Since wrinkle varnish was not clearly identified on the questionnaire, the reported utilization of tung oil for 1964 was considered to be lower than it otherwise would have been.

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BULLETIN 730 AUGUST 1966

Returns From Alternative Organizations, Grade "A" Dairy Farms, Northeast Mississippi

By

Verner G. Hurt and Albert L. McLaughlin

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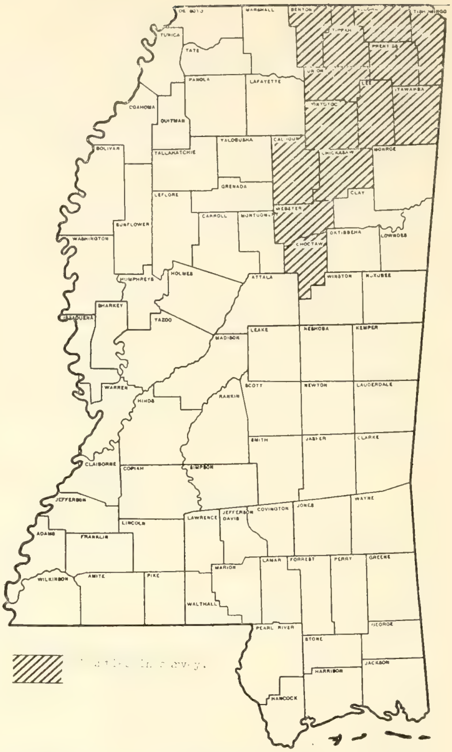
INTRODUCTION

In recent years, the number of Grade "A" dairy herds in Mississippi has decreased steadily. For example, there were 4,198 herds in the state on January 1, 1957, but only 2,392 on the same date in 1965.[1] In 13 counties in Northeast Mississippi, Figure 1, the number of herds declined by 45 percent during this period—from 561 to 311.[2]

On many Grade "A" dairy farms in Northeast Mississippi row crops, primarily cotton and corn are also important enterprises.[3] On these farms increases in herd size and production per cow have necessitated sharp increases in both management and investment requirements per herd. At the same time, the availability of part-time day labor has decreased. With these attendant changes, producers are faced with the problem of selecting the most profitable enterprises and farm organizations for their resource situations. Are they to move toward a specialized dairy type-of-farm organization or would a diversified row-crop dairy farm organization be more profitable? Recent changes in price-cost relationships and labor availability are important factors in this decision.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MARSHALL
BENTON
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ITAWAMBA
COAHOMA
QUITMAN
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SHARKEY
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YAZOO
MADISON
LEAKE
NESHOBA
KEMPER
WARREN
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LAUDERDALE
HINDS
RANKIN
SMITH
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CLARKE
CLAIBORNE
COPIAH
SIMPSON
JEFFERSON
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COVINGTON
JONES
LAWRENCE
LINCOLN
ADAMS
FRANKLIN
MARION
LAMAR
FORREST
PERRY
GREENE
WILKINSON
AMITE
PIKE
WALTHALL
PEARL RIVER
GEORGE
STONE
JACKSON
HARRISON
HANCOCK
▨ Counties in survey.

Figure 1. Counties in 1961 dairy survey, Mississippi.

OBJECTIVES

The objectives of this study were: (1) to evaluate alternative organizations for farms with resources similar to those found in Northeast Mississippi, and (2) to examine the effect of relative changes in the level of net returns from the dairy enterprise upon enterprise combinations.

SCOPE AND METHOD

A survey made in 1961 obtained data for the 1960 operation of 66 dairy farms in Northeast Mississippi. These farms included one-seventh of all Grade "A" dairy farms which operated for the full year in the 13 counties, plus all other farms with herds of over 60 cows.[1] Three resource situations were defined. For convenience, these are referred to as small, medium and large farms.

---

[1] Mississippi Crop and Livestock Reporting Service, SRS, USDA and Mississippi Department of Agriculture & Commerce, "Number of Grade "A" Dairy Herds in Mississippi as of Jan. 1, 1957-65."

[2] **Ibid.**

[3] McLaughlin, Albert L., "An Economic Evaluation of Grade "A" Milk Production in Northeast Mississippi," unpublished Master's thesis, Department of Agricultural Economics, Mississippi State University, State College, Mississippi, August, 1964; and unpublished data, Department of Agricultural Economics, Mississippi State University.

Factor inputs and yields consistent with a good level of management practices were used in constructing budgets for this study. Production per cow for the dairy budgets was the average attained by the top one-third of the producers in the survey. Prices and costs are those that prevailed in the area in 1965, Appendix Tables 1-2.

Much of the input-data—particularly feed requirements—used in constructing the dairy budgets was based on recommendations of the Dairy Department, Mississippi State University. Estimates of investment costs were developed from secondary sources. Linear and integer programming techniques were used to calculate the alternative organizations for the three size situations.

RESOURCES

Resource levels used for the three size groupings were based upon averages of existing 1960 resource situations. Thus, as averages, these particular resource levels by groups, do not, except by accident, fit any specific farm situation. They do, however, serve as guides to possible adjustments for those producers whose resource situations approximate these averages. Resource levels for land and labor for the three farm sizes, as programmed, are shown in Table 1. In programming alternative farm organizations these assumptions were made about available resources:

Land. All crop and open pasture land was considered suitable for pasture, silage or crops, with one exception. No winter grazing crops were to be planted on bottomland subject to overflow. Farms in the survey had relatively small acreages of woodland per farm and small amounts of upland native pasture in relation to total acreage.

Labor. Operator labor was based upon a maximum of 3,000 hours per man per year and was prorated to each month. Field labor each month was based on ten hours per day for days suitable for field work[1] with the remainder available for livestock labor. Use of field labor for livestock chores was permitted but livestock labor could not be used for field work. On small farms, other family labor was available for one-half of the milking chores and for cleaning the dairy. Such was not the case for medium and large farms.

Day labor for hoeing and harvesting crops could be hired at a cost of 45 cents per hour. Additional labor for livestock and other field work could be hired on a yearly basis at a salary of $2,400.

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[1] Some of the results of this survey were reported in McLaughlin, **op. cit.**

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[1] Parvin, D. W., "Farm Management Laboratory Manual," Mississippi State University, (processed) (undated).

Table 1. Resource levels for programming, by size of farm, dairy farms, Northeast Mississippi.

Resource	Unit	Farm size Small	 Medium	 Large
Land				
Oveflow bottom	acre	9.0	27.0	74.0
Not overflow bottom	acre	67.0	71.0	171.0
Bench or terrace	acre	18.0	51.0	86.0
Upland	acre	45.0	92.0	169.0
Total		139.0	241.0	500.0
Cotton allotment	acre	15.0	14.0	26.0
Livestock labor				
January	hrs.	242	135	135
February	hrs.	207	110	110
March	hrs.	202	95	95
April	hrs.	191	87	87
May	hrs.	172	65	65
June	hrs.	161	57	57
July	hrs.	162	55	55
August	hrs.	142	35	35
September	hrs.	151	47	47
October	hrs.	172	65	65
November	hrs.	181	77	77
December	hrs.	261	152	152
Total		2,244[1]	980	980
Field labor				
January	hrs.	120	120	120
February	hrs.	120	120	120
March	hrs.	160	160	160
April	hrs.	160	160	160
May	hrs.	190	190	190
June	hrs.	190	190	190
July	hrs.	200	200	200
August	hrs.	220	220	220
September	hrs.	200	200	200
October	hrs.	190	190	190
November	hrs.	170	170	170
December	hrs.	100	100	100
Total		2,020	2,020	2,020

---

[1] Includes 1,264 hours of family labor for milking chores and cleaning of the dairy.

Capital. Operating capital was required for the crop operations but not for the dairy. As much as was required was considered available at an interest rate of six percent per annum. No limitations were placed on the availability of capital for investment purposes.

ENTERPRISES

Crops. Crop budgets were prepared, where applicable, for the different land types, Appendix Tables 10-33. Custom harvesting was budgeted for the cotton enterprise. In addition, thirty-five percent of the cotton allotment was to be diverted and prices were adjusted accordingly. Crops considered, in addition to cotton, were corn for grain and silage, soybeans, oats for grazing, temporary summer pasture and permanent pasture.

Dairy. The budget prepared for the dairy enterprise reflects an average production of 7,350 pounds of milk and 273 pounds of butterfat per cow, Table 2. Requirements per cow for pasture, roughage other than pasture, and the grain ration are those required for the indicated level of production. Additional grain and forage for supplemental feeding of calves and replacement heifers was included in the herd ration. All heifers were to be raised to permit greater culling.

Labor requirements were based upon the per-cow requirements found in the survey with increases to reflect raising all heifers to calving age, Appendix Table 3. These labor requirements were developed for a milk parlor rather than a stanchion arrangement.

Estimated investment in specialized dairy equipment and livestock based on a 50-cow herd was $829.24 per cow, Table 3. This cost does not include investment in land or in the field equipment used to produce grain and forage.

Table 2. **DAIRY ENTERPRISE — Estimated costs and returns per cow, 50-cow herd.**

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Income				
Milk sold	cwt.	73.50	5.06	371.91
Cattle sold				90.28
Total				462.19
Cash expenses				
Concentrates[1]				
Cottonseed meal	cwt.	13.20	4.30	56.76
Corn (ear)	bu.	28.34	1.42	40.24
Salt	cwt.	.33	1.75	.58
Deflourinated phosphate	cwt.	.33	3.25	1.07
Grinding and mixing	cwt.	20.50	.35	7.17
Calf starter	cwt.	2.40	4.30	10.32
Milk replacer	cwt.	.125	17.60	2.20
Roughage[2]				
Silage (corn)	acre	1.0	35.00	35.00
Pasture (permanent)	acre	2.0	8.75	17.50
Pasture (temp. winter)	acre	1.0	19.38	19.38
Pasture (temp. summer)	acre	.5	23.74	11.87
Hauling and ADA	cwt.	73.50	.42	30.87
Veterinary expense	hd.	1.0	3.61	3.61
Electricity	hd.	1.0	4.98	4.98
Miscellaneous supplies	hd.	1.0	11.59	11.59
Total cash expenses				253.14
Net returns above specified cash expenses				209.05

[1] Market prices used for these input items.

[2] Costs based on estimated costs of producing.

Table 3. DAIRY ENTERPRISE — Estimated investment and depreciation per 50-cow herd.

Item	Unit	No.	Cost	Est. life in years	Annual depreciation
			dollars		dollars
Facilities					
Pipeline milkers	ea.	4	1800.00	12	150.00
Bulk tank (400 gal.)	ea.	1	2000.00	15	134.00
Milk cleaning equipment	ea.	1	300.00	10	30.00
Hot-water heater	ea.	1	60.00	5	12.00
Loafing barn	ea.	1	3000.00	20	150.00
Replacement housing	ea.	1	1800.00	20	90.00
Milking parlor & milk room	ea.	1	3100.00	20	155.00
Grain storage	ea.	1	800.00	20	40.00
Concrete pavement	sq. ft.	7,000	1200.00	20	60.00
Silo (20 x 50)	ea.	1	3890.00	25	155.60
Automatic feeding (including troughs)	ea.	1	1917.00	10	191.70
Blower (silage)	ea.	1	800.00	5	160.00
Fencing	mi.	3	1920.00	20	96.00
Total			22587.00		1424.30
Per cow			451.74		28.49
Livestock					
Cows @ $250	ea.	50	12500.00	5	1250.00
Heifers and calves (replacements)	ea.	30	6375.00	-	-
Total			18875.00		1250.00
Per cow			377.50		25.00
Total			41462.00		2674.30
Per cow			829.24		53.49

ALTERNATIVE ORGANIZATIONS

Linear programming techniques were used to generate alternative farm organizations for each of the three resource situations. Three type-of-farming organizations were calculated for each of the resource situations. These were (1) specialized dairy, (2) cotton-dairy, and (3) cotton-soybean-dairy. A fourth, cotton-soybeans with no dairy enterprise was examined for the small farms.

Crop and pasture acreages and numbers of dairy cattle for each resource situation and each type-of-farming organization are shown in Tables 4-6. Acreages of each crop planted on the specified types of land are shown in Appendix Tables 4-6. Estimated investment and depreciation for each situation are based on Appendix Tables 7-9.

On the basis of returns above specified cash expenses—with depreciation expense not considered—the cotton-soybeans-dairy organization yielded the highest returns on small farms while the cotton-dairy organization had the highest returns for medium and large farms. These same organizations yielded the highest returns for the small and the large farms when both cash costs and depreciation expense were considered. For the medium farms, however, the cotton-soybean-dairy rather than cotton-dairy organization was better when an allowance was made for depreciation.

Returns to labor and management (returns above specified cash expenses, depreciation, and interest on investment) were highest for the cotton-soybean-dairy organization for all three farm sizes. Returns to labor and management were slightly higher on small farms—$4,125 as compared to $3,972 and $4,007 for the medium and large farms, respectively, Tables 4-6. This was partly the result of family labor being utilized on the small farms for milking chores and dairy clean up, with its cost not being charged as an expense. Another factor which could have influenced the results was the requirement that each man hired for work other than hoeing and harvesting had to be hired for a full year at a salary of $2,400. Consequently, there may have been a better balance between labor and other resources for the one resource situation than for the others.

EFFECT OF INCREASING RETURNS TO DAIRY ENTERPRISE ON ORGANIZATION

The returns to the dairy enterprise may be increased by (1) an increase in the Class I or Class II milk prices, (2) a shift in the utilization of the milk, from Class II to Class I, with no change in class prices, (3) an increase in the production per cow provided cost increases are not offsetting, (4) a reduction in the costs of producing milk, or (5) some combination of the above. For purposes of this analysis, the budgeted returns per cow to the dairy enterprise were increased by $5 increments up to a total increase of $100. The resulting farm organizations for each farm size are shown in Tables 7-9.

Table 4. SMALL FARMS: Alternative organizations for specified types of farms, Northeast Mississippi, 1966.

Description	Unit	Type of farm			
		Specialized dairy	Cotton-dairy	Cotton-soybeans-dairy	Cotton-soybeans
Crops:					
Cotton	acs.	0.0	9.8	9.8	9.8
Corn	”	9.8	9.9	7.3	0.0
Corn silage	”	18.1	18.2	14.0	0.0
Oats	”	20.0	20.0	15.0	0.0
Temp. summer pasture	”	10.0	10.0	7.5	0.0
Dallis clover	”	44.1	44.4	34.5	0.0
Soybeans	”	0.0	0.0	53.2	97.4
Dairy cattle	#	20.0	20.0	15.0	0.0
Purchased inputs:					
Hire day labor	hrs.	0.0	5.7	10.5	6.3
Others:					
Diverted acreage	acs.	0.0	5.2	5.3	5.3
Idle land	”	47.00	31.5	0.0	0.0
Capital					
Operating	dols.	1,662.85	2,062.18	2,434.62	1,738.24
Investment:					
Specialized dairy equip. & livestock	”	17,208.63	17,213.25	12,926.16	0.0
Land and buildings	”	22,648.00	22,648.00	22,648.00	22,648.00
Power and equipment	”	9,952.00	9,952.00	12,412.00	12,412.00
Total investment	”	49,808.63	49,813.25	47,986.16	35,060.00
Other expenses:					
Depreciation - Specialized dairy equipt.	”	569.80	569.80	427.35	0.0
Depreciation - Power & equipment	”	744.62	744.62	990.62	990.62
Total depreciation	”	1,314.42	1,314.42	1,417.97	990.62

Continued

Table 4. Continued.

Description	Unit	Type of farm			
		Specialized dairy	Cotton-dairy	Cotton-soybeans-dairy	Cotton-soybeans
Interest on average invest. in dairy enterprise @ 6%	”	761.48	761.76	572.25	0.0
Interest on average invest, in power & equipt. @ 6%	”	298.56	298.56	372.36	372.36
Interest on average invest. in land & bldgs. @ 6%	”	1,358.88	1,358.88	1,358.88	1,358.88
Total interest	”	2,418.92	2,419.20	2,303.49	1,731.24
Net returns above specified cash expenses	”	5,016.53	6,461.11	7,846.99	6,143.48
Return above specified cash expenses & depreciation	”	3,702.11	5,146.69	6,429.02	5,152.86
Returns to labor & management	”	1,283.19	2,727.49	4,125.53	3,421.62

Table 5. MEDIUM FARMS: Alternative organizations for specified types of farms, Northeast Mississippi, 1966.

Description	Unit	Type of farm		
		Specialized dairy	Cotton-dairy	Cotton-soybeans-dairy
Crops:				
Cotton	acres	0.0	9.1	9.1
Corn	"	22.0	22.0	6.8
Corn silage	"	40.7	40.7	12.6
Oats	"	45.0	45.0	14.0
Temporary summer pasture	"	22.5	22.5	7.0
Dallis clover pasture	"	98.9	102.0	28.0
Soybeans	"	0.0	0.0	165.60
Dairy cattle	#	45.0	45.0	14.0
Purchased inputs:				
Hire full time labor	men	1.0	1.0	1.0
Others:				
Diverted acreage	acres	0.0	4.9	4.9
Idle land	"	34.4	17.3	0.0
Capital				
Operating	dols.	3,740.04	4,109.48	3,796.72
Investment				
Specialized dairy equipt. & livestock	"	38,715.00	38,758.00	12,005.00
Land and buildings	"	36,131.00	36,131.00	36,131.00
Power and equipment	"	21,046.00	21,046.00	26,026.00
Total investment	"	95,892.00	95,935.00	74,102.00
Other expenses				
Depreciation on specialized dairy equipment	dols.	1,282.05	1,282.05	398.86
Depreciation on power and equipt.	"	1,621.23	1,621.23	2,119.23

Continued

Table 5. Continued.

Description	Unit	Type of farm		
		Specialized dairy	Cotton-dairy	Cotton-soybeans-dairy
Total depreciation	”	2,903.28	2,903.28	2,518.09
Interest on average invest. dairy enterprise @ 6%	”	1,713.06	1,715.64	530.57
Interest on average invest. in power & equipt. @ 6%	”	631.38	631.38	778.98
Interest on average invest. in land & buildings @ 6%	”	2,167.86	2,167.86	2,167.86
Total interest	”	4,512.30	4,514.88	3,477.41
Net returns above specified cash expenses	”	8,888.30	10,262.08	9,967.94
Returns above specified cash expenses & depreciation	”	5,985.02	7,358.80	7,449.85
Returns to operator labor & management	”	1,472.72	2,843.92	3,972.44

Table 6. LARGE FARMS: Alternative organization for specified types of farms, Northeast Mississippi, 1966.

Description	Unit	Type of farm		
		Specialized dairy	Cotton-dairy	Cotton-soybeans-dairy
Crops:				
Cotton	acres	0.0	16.9	16.9
Corn	"	51.8	49.4	11.7
Corn-silage	"	102.5	97.2	21.6
Oats	"	110.0	104.0	24.0
Temporary summer pasture	"	55.0	52.0	12.0
Dallis clover pasture	"	235.6	223.4	48.0
Soybeans	"	0.0	0.0	368.7
Dairy cattle	#	110.0	104.0	24.0
Purchased inputs:				
Corn	bu.	111.8	80.5	0.0
Hire full-time labor	men	4.0	4.0	4.0
Other:				
Diverted acreage	acres	0.0	9.1	9.1
Capital				
Operating	dols.	9,447.18	9,598.77	7,753.90
Investment				
Specialized dairy equip. & livestock	"	94,548.14	89,400.31	20,580.48
Power and equipment	"	25,447.00	25,447.00	37,697.00
Land and buildings	"	98,229.00	98,229.00	98,229.00
Total investment	"	218,224.14	213,076.31	156,506.48
Other expenses:				
Depreciation on specialized dairy equipt.	"	3,133.9	2,962.96	683.76
Depreciation on power and equipt.	"	1,918.2	1,918.2	3,143.2
Total depreciation	"	5,052.1	4,881.16	3,826.96

Continued

Table 6. Continued.

Description	Unit	Type of farm		
		Specialized dairy	Cotton-dairy	Cotton-soybeans-dairy
Int. on average invest. in dairy enterprise @ 6%	”	4,182.15	3,954.66	909.58
Int. on average invest. in power & equipt. @ 6%	”	763.41	763.41	1,130.91
Int. on invest. in land & bldgs. @ 6%	”	5,893.74	5,893.74	5,893.74
Total interest	”	10,839.3	10,611.81	7,934.23
Net returns above specified cash exps.	”	17,506.09	18,631.11	15,768.53
Returns above specified cash exps. & dep.	”	12,453.99	13,749.95	11,941.57
Returns to labor & management	”	1,614.69	3,138.41	4,007.34

Programmed supply response relationships for each size of farm based on the results obtained are shown in Figures 2-4. In essence, the relationships obtained from the results of the analysis set an upper limit on the supply response and as such provide guidelines that reflect the magnitude of the incentive to adjust farm organizations. These relationships should not be interpreted as applying to the industry or to an individual farm. They are not representative of any specific farm, since the resource situations programmed were averages rather than some specific farm situation. Furthermore, the results obtained presuppose optimal enterprise adjustments based on the relationships between inputs, outputs, and prices used in developing budgets. These same demurrers hold for interpretations of aggregate relationships. The diversity of the existing resource situations between farms would likely result in widely divergent responses from farm to farm.

SUMMARY

Grade "A" dairy herds in Mississippi have decreased in numbers but increased in size and production in recent years. Similar changes have occurred in the 13 counties in Northeast Mississippi included in a survey of 66 dairy farms conducted in 1961. One of the major decisions confronting dairymen in this area is the choice of enterprises and the organization of their farms. Recent changes in price-cost relationships and labor availability are important factors in these decisions.

This study was conducted to (1) evaluate alternative farm organizations for farms with resources similar to those found in the area, and (2) examine the effect of relative changes in the level of net returns from the dairy enterprise upon the farm organization.

Results of the 1961 survey and data from secondary sources were used to construct budgets for the enterprises considered. Linear and integer programming techniques were used to calculate alternative farm organizations for three farm-size situations.

The results indicate that if a farmer has the capital to invest he can earn a six percent interest on it plus a return of around $4,000 for his labor and management. In none of the situations were returns to labor and management sufficient to provide for substantial repayments of borrowed capital and for family living expenses.

Table 7. SMALL FARMS: Alternative organizations, specified levels of returns per cow to dairy enterprise, Northeast Mississippi, 1966.

		Level of returns per cow to dairy enterprise							
Description	Unit	Budgeted returns to +$15	+$20	+$25	+$30 to +$40	+$45 to +$55	+$60 to +$75	+80 to +95	+$100
Returns above specified cash expenses	dols.	7,619.02	7,925.00	8,140.37	8,247.76- 8,389.66	8,635.44- 8,805.23	9,011.24- 9,294.92	9,391.62- 9,675.80	9,851.83
Crops:									
Cotton	acres	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
Corn	”	4.2	5.0	5.8	6.9	8.3	9.0	9.3	9.8
Dallis-clover pasture	”	20.0	24.5	28.5	32.9	38.8	44.3	44.4	47.5
Corn-silage	”	8.0	9.6	10.9	13.2	15.7	17.2	17.3	18.6
Soybeans	”	83.1	74.5	67.0	56.8	44.2	34.5	34.2	28.0
Oats[1]	”	8.7	10.3	11.8	14.2	17.0	18.9	19.0	20.2
Transfer to diverted acreage	”	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Dairy cattle	#	8.7	10.3	11.8	14.2	17.0	18.9	19.0	20.2
Purchased inputs									
Hired hoe labor	hrs.	9.2	8.1	8.2	9.9	12.1	13.0	13.1	0.0
Corn, bought	bu.	0.0	0.0	0.0	0.0	0.0	14.0	0.0	0.0
Capital									
Operating	dols.	2,296.97	2,329.34	2,357.82	2,414.82	2,473.02	2,467.45	2,472.09	2,532.93
Investment									
Specialized dairy equip. & livestock	dols.	7,455.63	8,909.56	10,188.25	12,232.56	14,628.03	16,308.90	16,337.91	17,422.03

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[1] One-half of this total acreage was to be planted for a temporary summer pasture following the oats.

Table 8. MEDIUM FARMS: Alternative organizations, specified levels of returns per cow to dairy enterprise, Northeast Mississippi, 1966.

		Level of returns per cow to dairy enterprise						
Description	Unit	Budgeted returns	+$5 to +$20	+$25 to +$30	+$35	+$40	+$45 to +$90	+$95 to +$100
Returns above specified cash expenses	dols.	9,996.36	10,474.66-10,788.90	11,512.71-11,665.22	12,006.18	12,694.92	13,075.56-15,082.08	15,312.90-15,536.44
Crops:								
Cotton	acres	9.1	9.1	9.1	9.1	9.1	9.1	9.1
Corn	"	7.1	10.2	14.9	16.4	20.5	21.8	21.9
Dallis clover pasture	"	28.9	41.9	66.6	74.9	92.6	98.4	99.2
Corn-silage	"	13.0	19.4	28.3	31.2	39.0	41.4	41.2
Soybeans	"	163.6	134.5	86.8	71.0	33.1	20.9	20.0
Oats[1]		14.5	21.0	30.5	33.5	41.9	44.6	44.7
Transfer to diverted acreage	"	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Dairy cattle	#	14.5	21.0	30.5	33.5	41.9	44.6	44.7
Purchased inputs								
Hired labor	men	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Capital								
Operating	dols.	3,805.18	4,019.37	4,209.81	4,268.62	4,444.55	4,496.38	4,486.37
Investment								
Specialized dairy equip. & livestock	dols.	12,395.76	17,964.89	26,234.75	28,824.51	36,055.42	38,366.37	38,476.63

[1] One-half of this total acreage was to be planted for a temporary summer pasture following the oats.

Table 9. LARGE FARMS: Alternative organizations, specified levels of returns per cow to dairy enterprise, Northeast Mississippi, 1966.

		Level of returns per cow to dairy enterprise							
Description	Unit	Budgeted returns	+$5 to +$20	+$25	+$30 to +$35	+$40	+$45 to +$70	+$75	+$80 to +$100
Returns above specified cash expenses	dols.	15,759.29	16,308.67- 16,826.91	19,196.31	20,416.79- 20,809.94	22,642.43	23,301.66- 25,894.46	26,902.13	27,571.80- 29,837.01
Crops:									
Cotton	acres	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9
Corn	”	11.7	16.9	31.6	38.4	49.5	50.7	17.0	9.1
Dallis-clover pasture	”	47.7	69.1	146.7	172.4	217.6	222.8	240.1	244.5
Corn-silage	”	21.4	32.0	60.0	72.8	94.8	96.8	105.4	107.2
Soybeans	”	369.4	321.5	171.0	111.7	10.8	0.0	0.0	0.0
Oats[1]	”	23.8	34.6	64.7	78.6	101.4	103.7	111.5	113.3
Transfer to diverted acreage	”	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
Dairy cattle	#	23.8	34.6	64.7	78.6	101.4	103.7	111.5	113.3
Purchased inputs									
Hired labor	men	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Capital									
Operating	dols.	7,748.61	8,101.84	8,704.73	9,036.61	9,561.85	9,605.12	9,433.33	9,381.57
Investment									
Specialized dairy equip. & livestock	dols.	20,442.63	29,627.03	55,738.56	67,641.34	87,126.44	89,152.43	95,854.98	97,377.40

[1] One-half of this total acreage was to be planted for a temporary summer pasture following the oats.

Figure 2. **SMALL FARMS:** Relationship between level of net returns from the dairy enterprise and production of Grade "A" milk per farm.

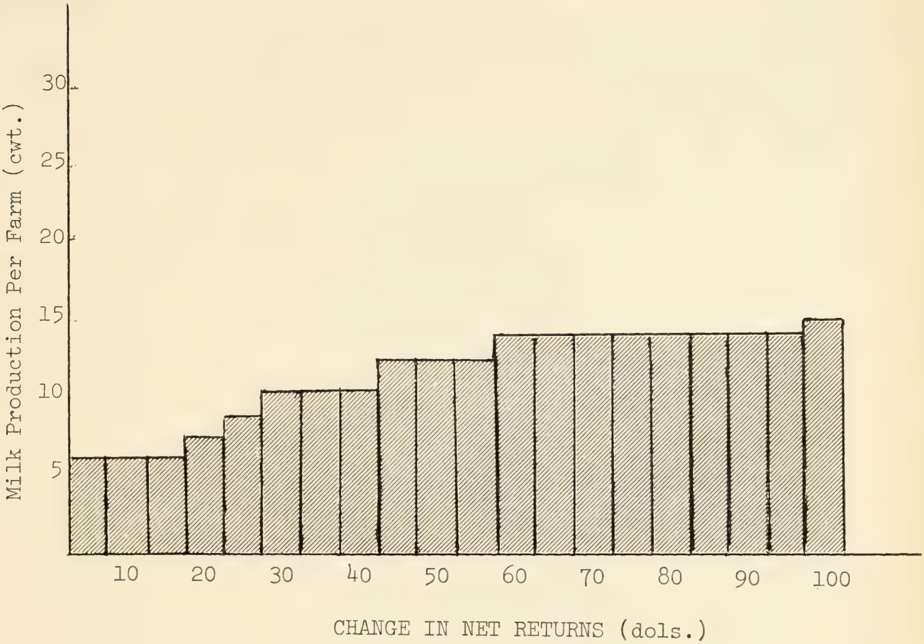


Figure 3. MEDIUM FARMS: Relationship between level of net returns from the dairy enterprise and production of Grade "A" milk per farm.

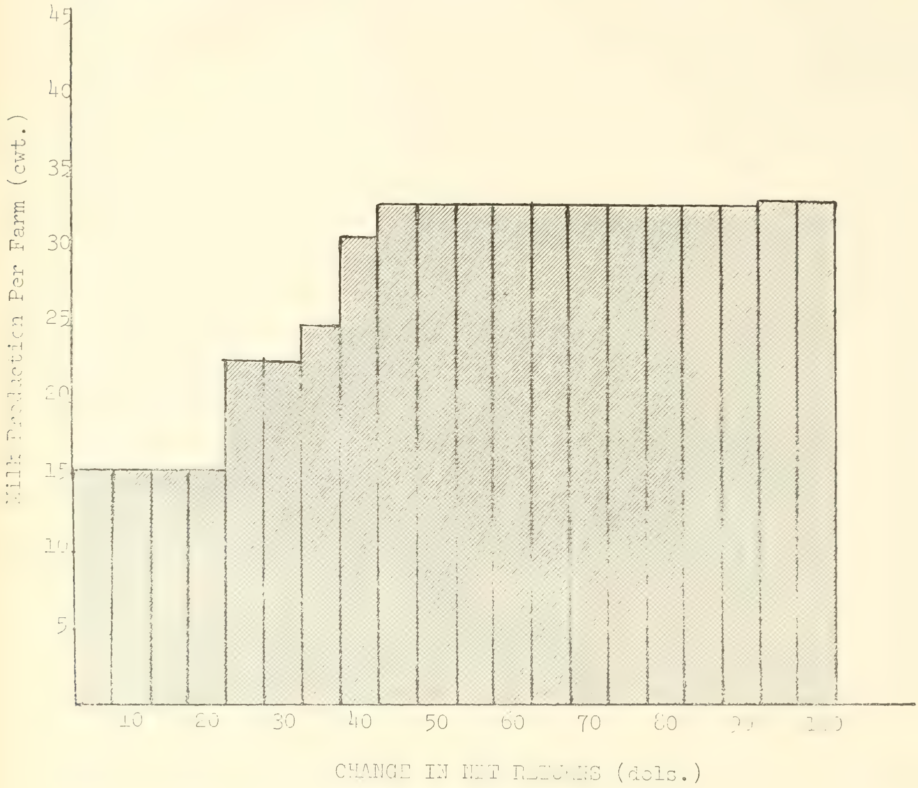
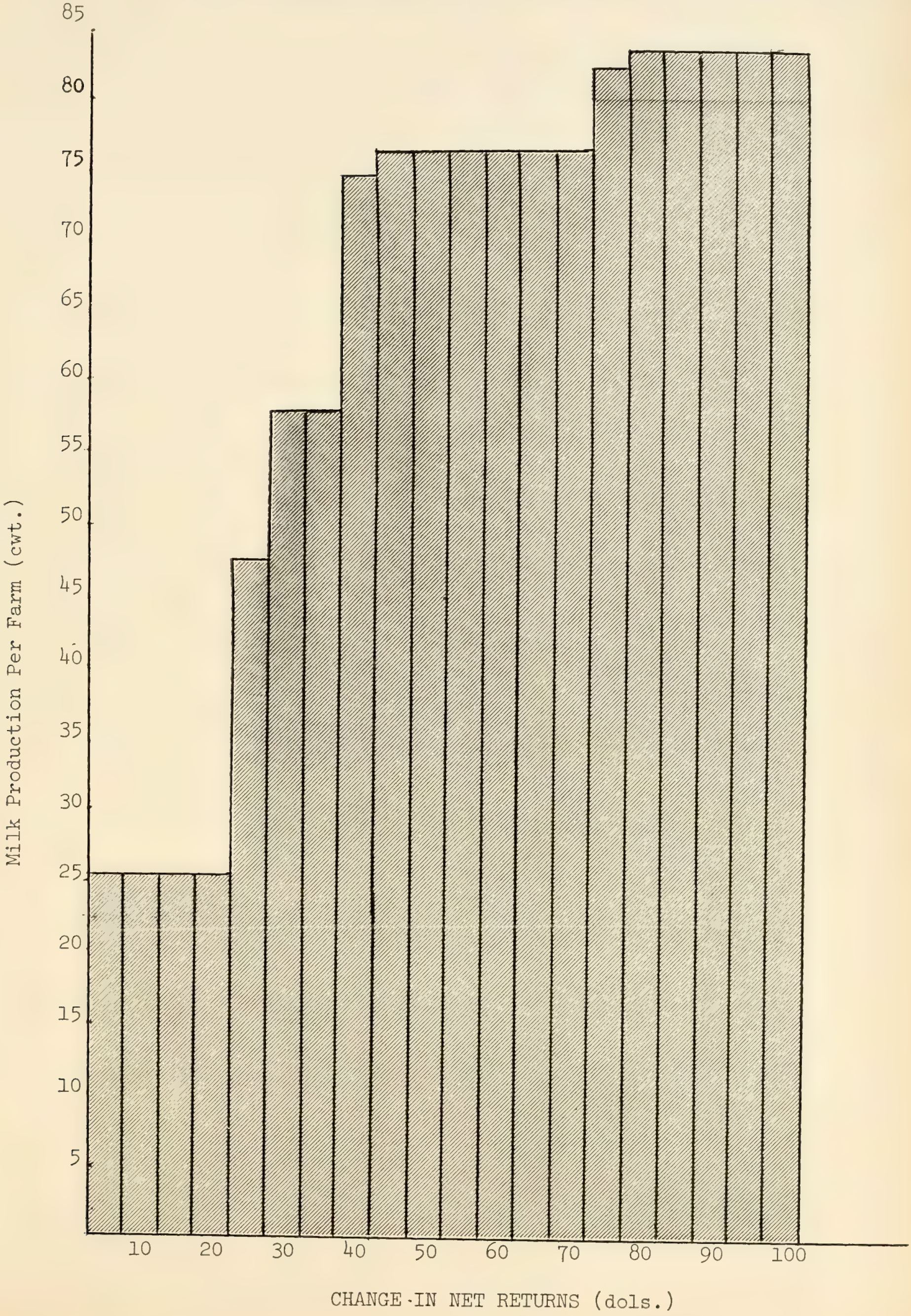


Figure 4. LARGE FARMS: Relationship between level of net returns from the dairy enterprise and production of Grade "A" milk per farm.



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Appendix Table 1. Estimated prices paid for selected input items, Northeast Mississippi, 1965.

Item	Unit	Amount
		dollars
SEED		
Cotton	cwt.	9.00
Corn	bu.	12.80
Dallis grass	lb.	1.20
White clover	lb.	.95
Millet	cwt.	10.00
Oats	bu.	1.50
Soybeans	bu.	4.25
FERTILIZER		
Ammonium nitrate	cwt.	3.78
6-12-12	cwt.	3.00
Lime	ton	5.55
Phosphate (53-54%)	cwt.	3.75
Potash	cwt.	2.90
5-10-10	cwt.	2.30
12-12-12	cwt.	3.26
9-12-12	cwt.	3.10
6-8-8	cwt.	2.20
13-13-13	cwt.	3.70
CHEMICALS		
Malathion	gal.	6.40
Toxaphene	gal.	2.40
DDT	gal.	1.60
Endrin	gal.	5.60
Karmex	gal.	14.00
Herbicidal oil	gal.	.23
Aldrin	gal.	3.60
GASOLINE	gal.	.283
FEED		
Cottonseed meal	cwt.	4.30
Salt	cwt.	1.75
Deflourinated phosphate	cwt.	3.25
Grinding & mixing	cwt.	.35
Calf starter	cwt.	4.30
Milk replacer	cwt.	17.60
Corn	bu.	1.42

Appendix Table 2. Estimated prices received for selected products, Northeast Mississippi, 1965.

Item	Unit	Amount
		dollars
Cottonseed	cwt.	2.40
Corn	bu.	1.32
Soybeans	bu.	2.70
Heifers (600#)	cwt.	20.60
Calves (400-450#)	cwt.	21.90

Appendix Table 3. Labor requirements: Hours per cow per month, by herd size, parlor barn, Northeast Mississippi.

Month	Herd size		
	Small	Medium	Large
January	8.47	8.98	6.72
February	7.65	8.15	5.82
March	7.88	9.19	6.42
April	5.88	4.77	5.26
May	5.71	4.80	4.38
June	5.52	4.64	4.24
July	5.71	4.80	4.38
August	5.71	4.81	4.38
September	5.88	4.62	4.55
October	6.94	8.75	6.27
November	7.93	8.60	6.75
December	8.24	9.03	7.19
Total	81.52	81.14	66.36

Appendix Table 4. SMALL FARMS: Land use patterns by soil type, type of farm and crops, Northeast Mississippi.

Type of farm and crop	Soil type				
	Overflow bottom	Non-overflow bottom	Bench or tableland	Upland	Total
			acres		
Available acres	9.0	67.0	18.0	45.0	139.0
Specialized dairy					
Corn	9.0		.8		9.8
Corn silage			14.3	3.8	18.1
Oats[1]		10.0		10.0	20.0
Dallis clover pasture		41.2	2.9		44.1
Idle land		15.8		31.2	47.0
Cotton-Dairy					
Cotton			9.8		9.8
Corn	9.0	.9			9.9
Corn-silage		4.3	8.2	5.7	18.2
Oats[1]		10.0		10.0	20.0
Dallis clover pasture		44.4			44.4
Diverted acreage		5.2			5.2
Idle land		2.2		29.3	31.5
Cotton-Soybean-Dairy					
Cotton			9.8		9.8
Corn	7.3				7.3
Corn-silage				13.9	13.9
Oats[1]				15.0	15.0
Dallis clover pasture	1.6	13.6	8.2	10.9	34.3
Soybeans		53.4			53.4
Diverted acreage				5.3	5.3
Cotton-Soybean					
Cotton			9.8		9.8
Soybeans	9.0	67.0	8.2	39.7	123.9
Diverted acreage				5.3	5.3

[1] One-half of this total acreage was used to be planted for temporary summer pasture following the oats.

Appendix Table 5. MEDIUM FARMS: Land use patterns by soil type, type of farm, and crops, Northeast Mississippi.

Type of farm and crop	Soil type				
	Overflow bottom	Non-overflow bottom	Bench or tableland	Upland	Total
	acres				
Available acres	27.0	71.0	51.0	92.0	241.0
Specialized dairy					
Corn	22.0				22.0
Corn silage			31.5	9.2	40.7
Oats[1]				45.0	45.0
Dallis clover pasture	5.0	71.0	19.5	3.4	98.9
Idle land				34.4	34.4
Cotton-Dairy					
Cotton			9.1		9.1
Corn	22.0				22.0
Corn-silage			31.5	9.2	40.7
Oats[1]				45.0	45.0
Dallis clover pasture	5.0	71.0	10.4	15.6	102.0
Diverted acreage				4.9	4.9
Idle land				17.3	17.3
Cotton-Soybean-Dairy					
Cotton			9.1		9.1
Corn	6.8				6.8
Corn-silage			12.6		12.6
Oats[1]				14.0	14.0
Dallis clover pasture			28.0		28.0
Soybeans	20.2	71.0	1.3	73.1	165.6
Diverted acreage				4.9	4.9

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[1] One-half of this total acreage was used to be planted for temporary summer pasture following the oats.

Appendix Table 6. LARGE FARMS: Land use patterns by soil type, type of farm, and crop, Northeast Mississippi.

Type of farm and crop	Soil type				
	Overflow bottom	Non-overflow bottom	Bench or tableland	Upland	Total
	acres				
Available acres	74.0	171.0	86.0	169.0	500.0
Specialized dairy					
Corn	51.8				51.8
Corn silage	22.2	25.8		54.6	102.6
Oats[1]				110.0	110.0
Dallis clover pasture		145.2	86.0	4.4	235.6
Cotton-Dairy					
Cotton			16.9		16.9
Corn	49.4				49.4
Corn-silage	23.6	16.7		56.9	97.2
Oats[1]				104.0	104.0
Dallis clover pasture		154.3	69.1		223.4
Diverted acreage				9.1	9.1
Cotton-Soybean-Dairy					
Cotton			16.9		16.9
Corn	11.7				11.7
Corn-silage			21.1	.5	21.6
Oats[1]				24.0	24.0
Dallis clover pasture			48.0		48.0
Soybeans	62.3	171.0		135.4	368.7
Diverted acreage				9.1	9.1

[1] One-half of this total acreage was used to be planted for temporary summer pasture following the oats.

Appendix Table 7. Estimated power and equipment requirements, investment and annual depreciation, small dairy farms, Northeast Mississippi.

Item	No.	Initial cost	Estimated life in years[1]	Annual depreciation
Tractor	1	$3,366	15	$224.40
Moldboard plow (2-b)	1	339	15	22.60
Disc harrow (2-r)	1	782	20	39.10
Section harrow	1	115	20	5.75
Planter (2-r)	1	421	20	21.05
Cultivators (2-r)	1	275	12	22.92
E-Z Flow	1	356	10	35.60
Grain Drill (2-r)	1	832	20	41.60
Wagon (Farm)	1	450	15	30.00
Combine (pull-type)	1	2,460	10	246.00
Corn Picker (1-r)	1	1,640	10	164.00
Pasture Clipper	1	673	10	67.30
Manure spreader	1	568	10	56.80
Spray equipment	1	135	10	13.50
Total - with combine		12,412		990.62
Total without combine		9,952		744.62

[1] Source: Tramel, Thomas E. and James T. Long, "Power and Equipment Cost in the Brown Loam Area of Mississippi," Mississippi Agricultural Experiment Station Bulletin 688, May 1964.

Appendix Table 8. Estimated power and equipment requirements, investment and annual depreciation, medium dairy farms, Northeast Mississippi.

Item	No.	Initial cost	Estimated life in years[1]	Annual depreciation
Tractor (2-r)	2	$6,732	15	$448.80
Moldboard plow (2-b)	2	678	15	45.20
Disc harrow (2-r)	2	1,564	20	78.20
Section harrow	1	115	20	5.75
Planters (2-r)	1	421	20	21.05
Cultivators (2-r)	2	550	12	45.83
E-Z Flow	1	356	10	35.60
Grain Drill (2-r)	1	832	20	41.60
Wagon (Farm)	1	450	15	30.00
Trailers (silage)	2	3,366	10	336.60
Combine (pull-type)	2	4,980	10	498.00
Corn picker (1-r)	1	1,640	10	164.00
Silage harvester	1	2,356	12	196.33
Pasture clipper	1	673	10	67.30
Manure loader	1	610	15	40.67
Manure spreader	1	568	10	56.80
Spray equipment	1	135	10	13.50
Total with combine		26.026		2,119.23
Total without combine		21,046		1,621.23

[1] Source: Tramel, Thomas E. and James T. Long, "Power and Equipment Cost in the Brown Loam Area of Mississippi," Mississippi Agricultural Experiment Station Bulletin 688, May 1964.

Appendix Table 9. Estimated power and equipment requirements, investment and annual depreciation, large dairy farms, Northeast Mississippi.

Item	No.	Initial cost	Estimated life in years[1]	Annual depreciation
Tractor (2-r)	3	$10,098	15	$673.20
Moldboard plow (2-b)	3	1,017	15	67.80
Disc harrow	2	1,564	20	78.20
Section harrow	1	115	20	5.75
Planters (2-r)	2	842	20	42.10
Cultivators (2-r)	3	825	12	68.75
E-Z Flow	1	356	10	35.60
Grain Drill	1	832	20	41.60
Wagon (Farm)	1	450	15	30.00
Trailer (silage)	2	3,366	10	336.60
Corn picker (1-r)	1	1,640	10	164.00
Silage harvester	1	2,356	12	196.33
Pasture clipper	1	673	10	67.30
Manure loader	1	610	15	40.67
Manure spreader	1	568	10	56.80
Spray equipment	1	135	10	13.50
Combine (self-propelled)	2	12,250	10	1,225.00
Total with combine		37,697.00		3,143.20
Total without combine		25,447		1,918.20

[1] Source: Tramel, Thomas E. and James T. Long, "Power and Equipment Cost in the Brown Loam Area of Mississippi," Mississippi Agricultural Experiment Station Bulletin 688, May 1964.

Appendix Table 10. COTTON: Estimated costs and returns per acre, bottomland subject to overflow, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Income				
Cotton lint	lbs.	550	.36[1]	198.00
Cottonseed	lbs.	808	.024	19.39
Total				217.39
Expenses				
Seed	cwt.	.42	9.00	3.78
Pre-emergence	gal.	13.9	.23	3.20
Fertilizer				
Ammonium nitrate	cwt.		3.78	
12-12-12	cwt.	2.50	3.26	8.15
Insecticide	acre	1	10.32	10.32
Tractor and equipment[2]	acre	1	11.39	11.39
Harvest (custom)[3]	acre		51.37	51.37
Ginning	cwt. lint	5.50	2.70	14.85
Miscellaneous[4]	acre	1	1.00	1.00
Total				104.06
Returns above specified costs				113.33

[1] Includes diversion payment based on 35% diversion rate.

[2] Includes $3.56 depreciation.

[3] Custom rate for machine picking is $.05 per pound of lint. In addition to machine cost, grade loss is 1.8 cents per pound of lint; field loss is five percent of seed cotton; and 10 percent of crop is hand-picked. Also, cost of defoliant and application must be added to expenses. The estimated cost of machine harvesting cotton is:

Hand picking cost	$ 4.76
Picker charges	23.38
Grade loss	9.40
Field loss	10.87
Defoliant and application	2.96
Total cost	$51.37

Based on Crecink, John C., "Budgets for Major Enterprises in the Clay-Hills of Mississippi," AEc. M.R. No. 45, Dept. of Ag. Econ., Miss. State University, March, 1965.

[4] Hoes, files, sacks, etc.

Appendix Table 11. COTTON: Estimated costs and returns per acre; bottomland not subject to overflow, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Income				
Cotton lint	lbs.	660	.36[1]	237.60
Cottonseed	lbs.	970	.024	23.28
Total				260.88
Expenses				
Seed	cwt.	.42	9.00	3.78
Pre-emergence	gal.	13.9	.23	3.20
Fertilizer				
Ammonium nitrate	cwt.		3.78	
12-12-12	cwt.	4.00	3.26	13.04
Insecticide	acre	1	10.32	10.32
Tractor & equipment[2]	acre	1	11.39	11.39
Harvest (custom)[3]	acre	1	61.04	61.04
Ginning	cwt. lint	6.60	2.70	17.82
Miscellaneous[4]	acre	1	1.00	1.00
Total				121.59
Returns above specified costs				139.29

[1] Includes diversion payment based on 35% diversion rate.

[2] Includes $3.56 depreciation.

[3] Custom rate for machine picking is $.05 per pound of lint. In addition to machine cost, grade loss is 1.8 cents per pound of lint; field loss is five percent of seed cotton; and 10 percent of crop is hand-picked. Also, cost of defoliant and application must be added to expenses. The estimated cost of machine harvesting cotton is:

Hand picking cost	$ 5.70
Picker charges	28.05
Grade loss	11.29
Field loss	13.04
Defoliant and application	2.96
Total cost	$61.04

Based on Crecink, John C., "Budgets for Major Enterprises in the Clay-Hills of Mississippi," AEc. M.R. No. 45, Dept. of Ag. Econ., Miss. State University, March, 1965.

[4] Hoes, files, sacks, etc.

Appendix Table 12. COTTON: Estimated cost and returns per acre; bench land, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Income				
Cotton lint	lbs.	715	.36[1]	257.40
Cottonseed	lbs.	1,051	.024	25.22
Total				282.62
Expenses				
Seed	cwt.	.42	9.00	3.78
Pre-emergence	gal.	13.9	.23	3.20
Fertilizer				
Ammonium nitrate	cwt.	.12	3.78	.45
12-12-12	cwt.	4.42	3.26	14.41
Insecticide	acre	1	10.32	10.32
Tractor & equipment[2]	acre	1	11.39	11.39
Harvest (custom)[3]	acre	1	65.90	65.90
Ginning	cwt. lint	7.15	2.70	19.30
Miscellaneous[4]	acre	1	1.00	1.00
Total				129.75
Returns above specified cost				152.87

[1] Includes diversion payment based on 35% diversion rate.

[2] Includes $3.56 depreciation.

[3] Custom rate for machine picking is $.05 per pound of lint. In addition to machine cost, grade loss is 1.8 cents per pound of lint; field loss is five percent of seed cotton; and 10 percent of crop is hand-picked. Also, cost of defoliant and application must be added to expenses. The estimated cost of machine harvesting cotton is:

Hand picking cost	$ 6.19
Picker charges	30.40
Grade loss	12.22
Field loss	14.13
Defoliant and application	2.96
Total cost	$65.90

Based on Crecink, John C., "Budgets for Major Enterprises in the Clay-Hills of Mississippi," AEc. M.R. No. 45, Dept. of Ag. Econ., Miss. State University, March, 1965.

[4] Hoes, files, sacks, etc.

Appendix Table 13. COTTON: Estimated costs and returns per acre, hill land, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Income				
Cotton lint	lbs.	550	.36[1]	198.00
Cotton seed	lbs.	808	.024	19.39
Total				217.39
Expenses				
Seed	cwt.	.42	9.00	3.78
Pre-emergence	gal.	13.9	.23	3.20
Fertilizer				
Ammonium nitrate	cwt.	.42	3.78	1.59
12-12-12	cwt.	5.00	3.26	16.30
Insecticide	acre	1	10.32	10.32
Tractor & equipment[2]	acre	1	11.39	11.39
Harvest (custom)[3]	acre	1		51.37
Ginning	cwt. lint	5.50	2.70	14.85
Miscellaneous[4]	acre	1	1.00	1.00
Total				113.80
Returns above specified costs				103.59

[1] Includes diversion payment based on 35% diversion rate.

[2] Includes $3.56 depreciation.

[3] Custom rate for machine picking is $.05 per pound of lint. In addition to machine cost, grade loss is 1.8 cents per pound of lint; field loss is five percent of seed cotton; and 10 percent of crop is hand-picked. Also, cost of defoliant and application must be added to expenses. The estimated cost of machine harvesting cotton is:

Hand picking cost	$ 4.76
Picker charges	23.38
Grade loss	9.40
Field loss	10.87
Defoliant and application	2.96
Total cost	$51.37

Based on Crecink, John C., "Budgets for Major Enterprises in the Clay-Hills of Mississippi," AEc. M.R. No. 45, Dept. of Ag. Econ., Miss. State University, March, 1965.

[4] Hoes, files, sacks, etc.

Appendix Table 14. CORN: Estimated costs and returns per acre; bottomland subject to overflow, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Income				
Corn	bu.	58	1.32	76.56
Expenses				
Preharvest				
Seed	bu.	.2	12.80	2.56
Fertilizer				
Ammonium nitrate	cwt.	1.47	3.78	5.56
12-12-12	cwt.	2.00	3.26	6.52
Tractor and equipment	acre	1	8.23	8.23
Miscellaneous	acre	1	1.00	1.00
Total preharvest				23.87
Harvest				
Machine	acre	1	5.74	5.74
Hand	acre	1	2.24	2.24
Total expense				
Machine harvest[1]				29.61
Hand harvest[2]				26.11
Returns above specified costs				
Machine harvest				46.95
Hand harvest				50.45

[1] Includes $5.35 depreciation.

[2] Includes $3.65 depreciation.

Appendix Table 15. CORN: Estimated costs and returns per acre; bottomland not subject to overflow, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Income				
Corn	bu.	52	1.32	68.64
Expenses				
Preharvest				
Seed	bu.	.2	12.80	2.56
Fertilizer				
Ammonium nitrate	cwt.	1.41	3.78	5.33
12-12-12	cwt.	2.50	3.26	8.15
Tractor and equipment	acre	1	8.23	8.23
Miscellaneous	acre	1	1.00	1.00
Total preharvest				25.27
Harvest				
Machine	acre	1	5.74	5.74
Hand	acre	1	2.24	2.24
Total expense				
Machine harvest[1]				31.01
Hand harvest[2]				27.51
Returns above specified costs				
Machine harvest				37.63
Hand harvest				41.13

[1] Includes $5.35 depreciation.

[2] Includes $3.65 depreciation.

Appendix Table 16. CORN: Estimated costs and returns per acre; bench land, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Income				
Corn	bu.	59	1.32	77.88
Expenses				
Preharvest				
Seed	bu.	.2	12.80	2.56
Fertilizer				
Ammonium nitrate	cwt.	1.53	3.78	5.78
12-12-12	cwt.	2.50	3.26	8.15
Tractor and equipment	acre	1	8.23	8.23
Miscellaneous	acre	1	1.00	1.00
Total preharvest				25.72
Harvest				
Machine	acre	1	5.74	5.74
Hand	acre	1	2.24	2.24
Total expense				
Machine harvest[1]				31.46
Hand harvest[2]				27.96
Returns above specified costs				
Machine harvest				46.42
Hand harvest				49.92

[1] Includes $5.35 depreciation.

[2] Includes $3.65 depreciation.

Appendix Table 17. CORN: Estimated costs and returns per acre; hill land, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Income				
Corn	bu.	53	1.32	69.96
Expenses				
Preharvest				
Seed	bu.	.2	12.80	2.56
Fertilizer				
Ammonium nitrate	cwt.	1.08	3.78	4.08
12-12-12	cwt.	3.00	3.26	9.78
Tractor and equipment	acre	1	8.23	8.23
Miscellaneous	acre	1	1.00	1.00
Total preharvest				25.65
Harvest				
Machine	acre	1	5.74	5.74
Hand	acre	1	2.24	2.24
Total expense				
Machine harvest[1]				31.39
Hand harvest[2]				27.89
Returns above specified costs				
Machine harvest				38.57
Hand harvest				42.07

[1] Includes $5.35 depreciation.

[2] Includes $3.65 depreciation.

Appendix Table 18. SOYBEANS: Estimated costs and returns per acre; bottomland subject to overflow, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Income				
Soybeans	bu.	25	2.70	67.50
Expenses				
Seed	bu.	1.2	4.25	5.10
Tractor and equipment[1]	acre	1	19.37	19.37
Total cost				24.47
Returns above specified costs				43.03

[1] Includes $3.59 depreciation.

Appendix Table 19. SOYBEANS: Estimated costs and returns per acre; bottomland not subject to overflow, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	**dollars**
Income				
Soybeans	bu.	28.00	2.70	75.60
Expenses				
Seed	bu.	1.2	4.25	5.10
Tractor and equipment[1]	acre	1	19.37	19.37
Total cost				24.47
Returns above specified costs				51.13

[1] Includes $3.59 depreciation.

Appendix Table 20. SOYBEANS: Estimated costs and returns per acre; bench land, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	**dollars**
Income				
Soybeans	bu.	26	9.70	70.20
Expenses				
Seed	bu.	1.2	4.25	5.10
Tractor and equipment[1]	acre	1	19.37	19.37
Total cost				24.47
Returns above specified costs				45.73

[1] Includes $3.59 depreciation.

Appendix Table 21. SOYBEANS: Estimated costs and returns per acre; hill land, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	**dollars**
Income				
Soybeans	bu.	24	2.70	64.80
Expenses				
Seed	bu.	1.2	4.25	5.10
Tractor and equipment[1]	acre	1	19.37	19.37
Total cost				24.47
Returns above specified costs				40.33

[1] Includes $3.59 depreciation.

Appendix Table 22. CORN SILAGE: Estimated costs per acre; bottomland subject to overflow, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	**dollars**
Seed	bu.	.2	12.80	2.56
Fertilizer				
Ammonium nitrate	cwt.	1.29	3.78	4.88
12-12-12	cwt.	2.68	3.26	8.74
Tractor and equipment[1]	acre	1	20.41	20.41
Total				36.59

Yield: 9.3T/acre or 3.1 T. hay equivalent

[1] Includes $7.23 depreciation.

Appendix Table 23. CORN SILAGE: Estimated costs per acre; bottomland not subject to overflow, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	**dollars**
Seed	bu.	.2	12.80	2.56
Fertilizer				
Ammonium nitrate	cwt.	2.00	3.78	7.56
12-12-12	cwt.	1.52	3.26	4.96
Tractor and equipment[1]	acre	1	20.41	20.41
Total				35.49

Yield: 8.8 T/acre or 3.26 T. hay equivalent

[1] Includes $7.26 depreciation.

Appendix Table 24. CORN SILAGE: Estimated costs per acre; bench land, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	**dollars**
Seed	bu.	.2	12.80	2.56
Fertilizer				
Ammonium nitrate	cwt.	.58	3.78	2.19
12-12-12	cwt.	2.13	3.26	6.94
Tractor and equipment[1]	acre	1	20.41	20.41
Total				32.10

Yield: 10.0 T/acre or 3.33 T. hay equivalent.

[1] Includes $7.26 depreciation.

Appendix Table 25. CORN SILAGE: Estimated costs per acre; hill land, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Seed	bu.	.2	12.80	2.56
Fertilizer				
Ammonium nitrate	cwt.	1.00	3.78	3.78
12-12-12	cwt.	3.02	3.26	9.85
Tractor and equipment[1]	acre	1	20.41	20.41
Total				36.60

Yield: 9.7 T/acre or 3.23 T. hay equivalent.

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[1] Includes $7.26 depreciation.

Appendix Table 26. DALLIS GRASS AND CLOVER PASTURE: Estimated establishment and maintenance costs per acre, dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	dollars
Establishment				
Seeds				
Dallis grass	lb.	10.0	1.20	12.00
White clover	lb.	2.0	.95	1.90
Fertilizer				
Lime	ton	1.16	5.55	6.44
Ammonium nitrate	cwt.	.33	3.78	1.25
Phosphate	cwt.	1.51	3.75	5.66
Potash	cwt.	.78	2.90	2.26
Tractor and equipment[1]	acre	1.0	3.50	3.50
Total				33.01
Less ASC payment				17.71
Net cost				15.30
Maintenance				
Fertilizer				
Phosphate	cwt.	.34	3.75	1.28
Potash	cwt.	.16	2.90	.46
Tractor and equipment[2]	acre	1	1.94	1.94
Total				3.68

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[1] Includes $.98 depreciation.

[2] Includes $.75 depreciation.

Appendix Table 27. OATS FOR GRAZING: Estimated costs per acre; dairy farms, Northeast Mississippi.

Item	Unit	Quantity	Price	Amount
			dollars	**dollars**
Seed	bu.	4.0	1.50	6.00
Fertilizer				
Ammonium nitrate	cwt.	1.00	3.78	3.78
12-12-12	cwt.	1.25	3.26	4.08
Tractor and equipment[1]	acre	1.0	5.52	5.52
Total				19.38

[1] Includes $1.36 depreciation.

Appendix Table 28. COTTON: Annual labor, power and equipment requirements per acre; dairy farms, Northeast Mississippi.

Operation	Dates performed	Equipment size	Times over	Per acre once over	Time required/acre			Tractor & equipment cost per acre
					Man	Tractor	Equipment	
				Hours	**Hours**	**Hours**	**Hours**	**Dollars**
Break		2-bottom	1	1.5	1.5	1.5	1.5	2.34
Disc		6 foot	2	.6	1.2	1.2	1.2	1.81
Harrow		2-section	1	.5	.5	.5	.5	.60
Fertilize, plant, replant & pre-emerge		2-row	1	.6	.6	.6	.6	1.90
Cultivate		2-row	3	.6	1.8	1.8	1.8	2.34
Chop		—	1	13.3	13.3			
Poison		6-row	8	.2	1.6	1.6	1.6	2.40
TOTAL PRE-HARVEST					20.5	7.2	7.2	11.39
Harvest[1]		—			—	—	—	—
TOTAL HARVEST		—			—	—	—	—
TOTAL					20.5	7.2	7.2	11.39

[1] Custom.

Appendix Table 29. CORN: Annual labor, power and equipment requirements per acre; dairy farms, Northeast Mississippi.

Operation	Dates performed	Equipment size	Times over	Per acre once over	Time required/acre			Tractor & equipment cost per acre
					Man	Tractor	Equipment	
				Hours	Hours	Hours	Hours	Dollars
Break	3- 1 to 5-15	2-bottom	1	1.5	1.5	1.5	1.5	2.34
Disc	3- 1 to 6- 1	6-foot	2	.6	1.2	1.2	1.2	1.86
Harrow	4- 1 to 6-15	2-section	1	.5	.5	.5	.5	.60
Fertilize, plant, and replant	4- 1 to 6-15	2-section	1	.6	.6	.6	.6	1.90
Cultivate	4-15 to 7-15	2-row	3	.6	1.8	1.8	1.8	2.34
Chop	4-15 to 7-15		1	5.0	5.0			
TOTAL PRE-HARVEST					10.6	5.6	5.6	8.23
Harvest, machine	9- 1 to 12- 1	1-row			4.2	1.6	1.6	3.78
Harvest, hand	9- 1 to 12- 1	50 bu./load			12.6	1.7	1.7	2.24
Haul, machine[1]	9- 1 to 12- 1	50 bu./load				1.3	2.2	1.96
TOTAL (Hand harvest)					23.2	7.3	7.3	10.47
TOTAL (Machine harvest)					14.8	8.5	9.4	13.97

Source: Adapted from Verner G. Hurt, **Budgets for Major Farm Enterprises in the Yellow Creek Watershed**, Mississippi Agricultural Experiment Station, AEc. M. R. 37, April, 1963.

[1] Time trailer used.

Appendix Table 30. SOYBEANS: Annual labor, power, and equipment requirements per acre; dairy farms, Northeast Mississippi.

Operation	Dates performed	Equipment size	Times over	Per acre once over	Time required/acre			Tractor & equipment cost per acre
					Man	Tractor	Equipment	
				Hours	**Hours**	**Hours**	**Hours**	**Dollars**
Break	3- 1 to 5-15	2-bottom	1	1.5	1.5	1.5	1.5	2.34
Disc	3- 1 to 6-15	6-foot	2	1.6	1.2	1.2	1.2	1.86
Harrow	4- 1 to 6-10	2-section	1	.5	.5	.5	.5	.60
Fertilize, plant and replant	5- 1 to 6-10	2-row	.1	.6	.6	.6	.6	1.09
Cultivate	5-15 to 6-10	2-row	3	.6	1.8	1.8	1.8	2.32
TOTAL PRE-HARVEST					5.6	5.6	5.6	8.21
Harvest	9-28 to 12- 1	6-foot	1	1.2	1.2	1.2	1.2	3.61
Haul	9-20 to 12- 1	1 1/2 ton			.4			3.20
TOTAL HARVEST					1.6	1.2	1.2	6.81
TOTAL					7.2	6.8	6.8	15.02

Source: Adapted from Verner G. Hurt, **Budgets for Major Farm Enterprises in the Yellow Creek Watershed**, Mississippi Agricultural Experiment Station, AEc. M. R. 37, April, 1963.

Appendix Table 31. CORN SILAGE: Annual labor, power and equipment requirements per acre; dairy farms, Northeast Mississippi.

Operation	Dates performed	Equipment size	Times over	Per acre once over	Time required/acre			Tractor & equipment cost per acre
					Man	Tractor	Equipment	
				Hours	**Hours**	**Hours**	**Hours**	**Dollars**
Break	3- 1 to 5-15	2-bottom	1	1.5	1.5	1.5	1.5	2.34
Disc	3- 1 to 6- 1	6-foot	2	.6	1.2	1.2	1.2	1.86
Harrow	4- 1 to 6-15	2-section	1	.5	.5	.5	.5	.60
Fertilize, plant and replant	4- 1 to 6-15	2-row	1	.6	.6	.6	.6	1.09
Cultivate	4-15 to 7-15	2-row	2	.6	1.2	1.2	1.2	1.56
Harvest[1]	9- 1 to 9-30	1-row	1	1.0	1.7	1.7	1.7	5.43
Haul[1]	9- 1 to 9-30	tractor and trailer	1	1.0	8.6	3.6	4.2[2]	4.90
TOTAL					15.3	10.3	10.9	17.79

Source: Adapted from Verner G. Hurt, **Budgets for Major Farm Enterprises in the Yellow Creek Watershed**, Mississippi Agricultural Experiment Station, AEc. M. R. 37, April, 1963.

[1] Based on 9 to 10 tons per acre.

[2] Trailer time required for harvesting and hauling.

Appendix Table 32. DALLIS GRASS AND CLOVER PASTURE: Annual labor, power and equipment requirements per acre for establishment and maintenance, dairy farms, Northeast Mississippi.

Operation	Dates performed	Equipment size	Times over	Per acre once over	Time required/acre Man	Time required/acre Tractor	Time required/acre Equipment	Tractor & equipment cost per acre
				Hours	**Hours**	**Hours**	**Hours**	**Dollars**
Establish								
Disc	8- 1 to 10-15	6-foot	2	.6	1.2	1.2	1.2	1.86
Harrow	8- 1 to 10-15	2-section	1	.5	.5	.5	.5	.60
Seed	9- 1 to 10-15	7-ft. drill	1	.5	.5	.5	.5	1.04
TOTAL					2.2	2.2	2.2	3.50
Annual maintenance								
Chop	5- 1 to 8- 1	7-ft. mower	1	.5	.5	.5	.5	.90
Fertilize	5- 1 to 8- 1	10-ft.	1	.25	.25	.25	.25	1.04
TOTAL					.75	.75	.75	1.94

Source: Adapted from Verner G. Hurt, **Budgets for Major Farm Enterprises in the Yellow Creek Watershed**, Mississippi Agricultural Experiment Station, AEc. M. R. 37, April, 1963.

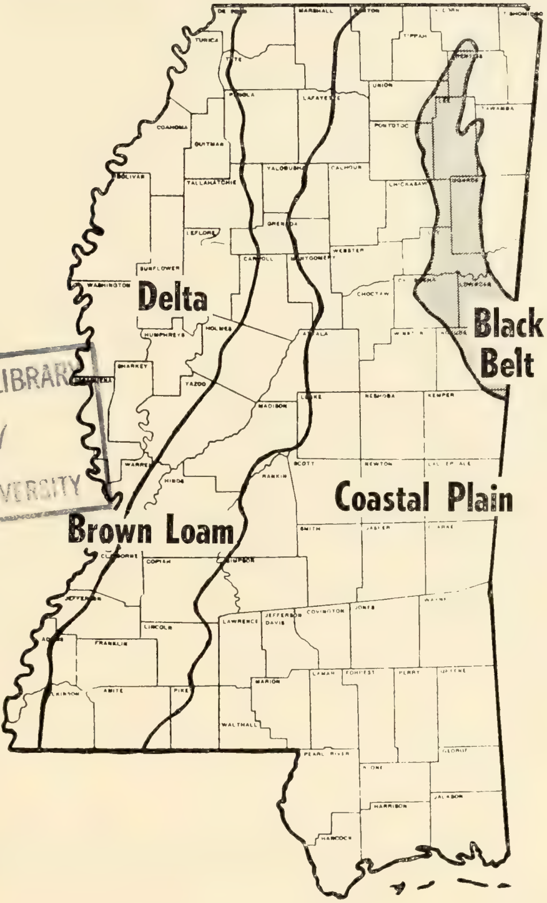
Appendix Table 33. OATS FOR GRAZING: Annual labor, power and equipment requirements per acre, dairy farms, Northeast Mississippi.

Operation	Dates performed	Equipment size	Times over	Per acre once over	Time required/acre			Tractor & equipment cost per acre
					Man	Tractor	Equipment	
				Hours	**Hours**	**Hours**	**Hours**	**Dollars**
Break	8-15 to 9-31	2-bottom	1	1.5	1.5	1.5	1.5	2.34
Disc	8-15 to 9-30	6-foot	1	.6	.6	.6	.6	.93
Harrow	8-15 to 9-30	2-section	1	.5	.5	.5	.5	.60
Seed	8-15 to 9-30	7-ft. drill	1	.5	.5	.5	.5	1.22
Fertilize	8-15 to 3- 1	10-ft. distributor	1	.25	.25	.25	.25	.52
TOTAL					3.35	3.35	3.35	5.61

Source: Adapted from Verner G. Hurt, **Budgets for Major Farm Enterprises in the Yellow Creek Watershed**, Mississippi Agricultural Experiment Station, AEc. M. R. 37, April, 1963.

Bulletin 731 October 1966

Normal Yields And Production Practices By Soil Types, Mississippi Black Belt Area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ACKNOWLEDGMENTS

The authors express appreciation to the many farmers of the Black Belt Area for supplying the information upon which this report is based. Also, appreciation is expressed to the many individuals of the Soil Conservation Service for supplying soil maps and their wholehearted cooperation in conducting the study. In addition, appreciation is expressed to Dr. D. W. Parvin, Head of the Department of Agricultural Economics and to Dr. C. Dale Hoover, Head of the Department of Agronomy for many helpful suggestions.

NORMAL YIELDS AND PRODUCTION PRACTICES
BY SOIL TYPES
MISSISSIPPI BLACK BELT AREA

by

Thomas E. Tramel, Walter E. Keenan, and Harvey B. Vanderford

The Black Belt of Mississippi is a crescent-shaped area that contains about 1.4 million acres. It begins in the northeastern part of the state and extends southward to Kemper County. See map on cover.

Soils of the area developed from soft limstone, generally called chalk, and clays over the chalk. The dark colored soils of the area developed directly from the weathered products of the chalk under a natural cover of grasses. These soils were called "Black Prairie" by the early settlers. The other upland soils of the area developed from the acid clays over the chalk under a natural cover of Postoak and other hardwoods. Early settlers called these soils "Postoak Prairie." All soils of the area are high in clay and are difficult to manage when used for cultivated crops. However, the fertility level is relatively high.

Because of the relatively high fertility of the soils of this area, an intensive agriculture, based on cotton as the major cash crop, developed early in the history of the State. This type of agriculture caused considerable soil erosion. However, the fertility level of Black Belt soils is still relatively high in comparison to other Coastal Plain soils. In addition, the soils respond well to special soil management practices. Thus soils of the area have high productive capacities when used for adapted crops or pastures.

Soil productivity depends to a large extent upon soil properties and the associated landscape. In soil survey work, scientists group soils of somewhat similar characteristics into "soil mapping units," taking into account differences in soil type, slope, and degree of erosion. Thus a given field may contain only one soil mapping unit or several soil mapping units. Soil mapping units, as recorded on soil maps of the Black Belt Area, served as the basis for collecting data for this study.

Because of the large number of soil mapping units in a Soil Area, it is not practical to attempt to obtain data on each one. Hence data were obtained only for those which make up a large part of the agricultural land of the area.[1] Soil mapping units for which data were obtained were organized into five productivity groups as indicated below.

---

[1] See Appendix A for sampling procedures.

SOIL MAPPING UNITS STUDIED, BY PRODUCTIVITY GROUPS

Deep, Dark Upland Soils

Brooksville silty clay, 0 to 2 percent slope.

Brooksville silty clay, 0 to 2 percent slope, eroded.

Brooksville silty clay, 2 to 5 percent slope.

Brooksville silty clay, 2 to 5 percent slope, eroded.

Houston clay, 0 to 2 percent slope.

Houston clay, 2 to 5 percent slope.

Houston clay, 2 to 5 percent slope, eroded.

Houston clay, 5 to 8 percent slope, eroded.

Houston silty clay, 0 to 2 percent slope, eroded.

Houston silty clay, 2 to 5 percent slope.

Houston silty clay, 2 to 5 percent slope, eroded.

Houston silty clay, 5 to 8 percent slope, eroded.

Moderately well drained, clayey bottomland soils

Catalpa silty clay.

Catalpa silty clay loam.

Kaufman silty clay.

Kaufman silty clay loam.

Marietta silt loam, moderately shallow.

West Point silty clay.

West Point silty clay, 0 to 2 percent slope.

Somewhat poorly drained clayey bottomland soils.

Houlka silty clay.

Houlka silty clay, local alluvium.

Houlka silty clay loam.

Leeper clay.

Leeper silty clay.

Leeper silty clay, local alluvium.

Leeper silty clay loam, 0 to 2 percent slope.

Leeper fine sandy loam, overwash.

Mottled "Postoak" soils.

Eutaw silt loam, 0 to 2 percent slope.

Eutaw silty clay, 0 to 2 percent slope.

Eutaw silty clay, 2 to 5 percent slope.

Geiger silty clay, 0 to 2 percent slope.

Geiger silt loam, 0 to 2 percent slope.

Vaiden silt loam, 0 to 2 percent slope.

Vaiden silt loam, 2 to 5 percent slope.

Vaiden silt loam, 2 to 5 percent slope, eroded.

Vaiden silty clay, 0 to 2 percent slope.

Vaiden silty clay, 0 to 2 percent slope, eroded.

Vaiden silty clay, 2 to 5 percent slope.

Vaiden silty clay, 2 to 5 percent slope, eroded.

Vaiden silty clay, 2 to 5 percent slope, severely eroded.

Vaiden silty clay, 5 to 8 percent slope, eroded.

Vaiden silty clay, 5 to 8 percent slope, severely eroded.

Wet bottomland soils.

Tuscumbia clay.

Tuscumbia silty clay.

Una clay.

Una silty clay loam.

Una silty clay loam, 0 to 2 percent slope.

Una soils.

Soil classification based upon physical characteristics is very useful for many purposes, one of which is farm planning. However, the usefulness for farm planning is dependent to a large extent upon knowledge of yields and production practices associated with each classification. This study was made to obtain estimates of normal yields and normal production practices associated with the most important soil mapping units of the Black Belt Area. Data for the study were obtained by personal interview with a sample of farmers in the Black Belt Area.

Generally, in order for data collected by personal interview to yield reliable averages, a relatively large number of observations is required. Because of this, results are reported only for situations for which ten or more observations were obtained.

Results of the study are presented for individual soil mapping units. However, a broader grouping of soils is generally preferred for farm planning purposes. In addition, in a study such as this, the broader grouping increases the number of observations upon which the results are based and, consepuently, the reliability of the results. Thus results are also presented for the five productivity groups indicated above.

Yield is dependent upon production practices as well as soil characteristics. Thus care must be exercised in interpreting differences in the yields reported in this study. Differences in the yields reported may be due to differences in production practices as well as differences in soil characteristics.

Normal yields and normal production practices are presented in Appendix B for cotton, corn, and soybeans for situations for which ten or more observations were obtained. For quick reference, yields are summarized in Table 1 by productivity groups.

Table 1. Normal yields by productivity groups, Mississippi Black Belt Area, 1966.[1]

	Crop		
Productivity Group	Cotton lb. lint/acre	Corn bu. per acre	Soybeans bu./acre
Deep dark upland soils	556	35	27
Moderately well drained bottomland soils	545	43	26
Somewhat poorly drained clayey bottomland soils	605	49	27
Mottled "Postoak" soils	428	27	22
Wet bottomland soils	569	50	26

[1] See Appendix B for production practices by productivity groups and for yields and production practices by soil mapping units.

Cotton

Average cotton yields ranged from 428 pounds per acre for mottled "Postoak" soils to an average of 605 pounds per acre for somewhat poorly drained clayey bottomland soils. Wet bottomland soils averaged 569 pounds per acre. The seemingly high yields on the somewhat poorly drained clayey bottomland soils and the wet bottomland soils are due to good surface drainage and good management practices. In general it appears that productivity of all the clayey soils for cotton is about equalized when good surface drainage is provided.

Corn

Average corn yields ranged from 27 bushels per acre on the mottled "Postoak" soils to 50 bushels on the wet bottomland soils. Somewhat poorly drained clayey bottomland soils averaged 49 bushels per acre. Again, production practices as well as soil characteristics are important in determining yield.

Soybeans

Soybean yields averaged 26 or 27 bushels per acre for each productivity group except mottled "Postoak" soils. This group averaged only 22 bushels per acre. While soybean production is fairly new in the area, these results indicate that acceptable yields are being obtained.

Appendix A

All completed soil maps of the area, each covering approximately four square miles, were studied and labeled with the predominant soil mapping unit. All soil mapping units for which it was felt that at least ten observations could be obtained for one or more crops were then selected for study.

For each soil mapping unit selected for study, all soils maps labeled as representing predominantly soils of the particular classification were arrayed by the flight numbers appearing on the aerial photograph. From this array, study maps were selected in a systematic manner to insure "spreading" of the study maps over the entire Black Belt Area.

An enumerator visited each farm located on the study maps and obtained, for each soil mapping unit represented on the farm, data relative to crops grown, normal yields, and normal production practices.

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Appendix Table 1. Cotton: Normal yield per acre and production practices, Brooksville silty clay, 0-2 percent slope. Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	596	596
Pounds of N	100.0	62	62
Pounds of P_2O_5	93.5	39	42
Pounds of K_2O	93.5	37	40
Other practices (times over):			
Flat breaking, fall	3.2	.03	1.00
Middle breaking, fall	74.2	.80	1.08
Middle breaking, spring	58.1	.71	1.22
Discing, fall	19.4	.29	1.50
Discing, spring	51.6	.74	1.43
Listing, fall	6.4	.06	1.00
Listing, spring	45.2	.45	1.00
Harrowing	100.0	1.58	1.58
Pre-emerge	16.1	.16	1.00
Post-emerge	9.7	.16	1.66
Hoeing	100.0	3.12	3.12
Flame cultivation	3.2	.10	3.00
Cultivation	100.0	6.54	6.54
Insecticides	93.5	7.06	7.55
Defoliation	6.4	.06	1.00

[1] Based on 31 observations.

Appendix Table 2. Cotton: Normal yield per acre and production practices, Brooksville silty clay, 2-5 percent slope, eroded, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	561	561
Pounds of N	100.0	65	65
Pounds of P_2O_5	95.2	42	44
Pounds of K_2O	95.2	42	44
Other practices (times over):			
Flat breaking, fall	2.4	.02	1.00
Flat breaking, spring	2.4	.02	1.00
Middle breaking, fall	90.4	.92	1.02
Middle breaking, spring	38.1	.40	1.06
Discing, fall	45.2	.52	1.15
Discing, spring	64.3	.88	1.37
Listing, fall	2.4	.02	1.00
Listing, spring	64.3	.64	1.00
Harrowing	100.0	1.57	1.57
Pre-emerge	26.2	.26	1.00
Post-emerge	4.8	.05	1.00
Hoeing	100.0	3.09	3.09
Flame cultivation	4.8	.14	3.00
Cultivation	100.0	5.85	5.85
Insecticide	92.8	7.99	8.61
Defoliation	7.1	.07	1.00

---

[1] Based on 42 observations.

Appendix Table 3. Cotton: Normal yield per acre and production practices, Catalpa silty clay, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	540	540
Pounds of N	98.4	70	71
Pounds of P_2O_5	82.6	34	41
Pounds of K_2O	82.6	34	41
Other practices (times over):			
Flat breaking, fall	4.8	.04	1.00
Flat breaking, spring	3.2	.03	1.00
Middle breaking, fall	73.0	.77	1.06
Middle breaking, spring	69.8	.89	1.27
Discing, fall	11.1	.11	1.00
Discing, spring	68.2	1.17	1.72
Listing, spring	31.7	.33	1.05
Harrowing	100.0	1.53	1.53
Pre-emerge	39.7	.40	1.00
Post-emerge	9.5	.14	1.50
Hoeing	98.4	2.96	3.01
Flame cultivation	1.6	.05	3.00
Cultivation	100.0	5.77	5.77
Insecticides	93.6	8.21	8.77
Defoliation	3.2	.03	1.00

---

[1] Based on 63 observations

Appendix Table 4. Cotton: Normal yield per acre and production practices, Houlka silty clay, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	561	561
Pounds of N	100.0	62	62
Pounds of P_2O_5	94.1	38	40
Pounds of K_2O	94.1	38	40
Other practices (times over):			
Middle breaking, fall	76.5	.79	1.03
Middle breaking, spring	67.6	.88	1.30
Discing, fall	14.7	.18	1.20
Discing, spring	64.7	.94	1.45
Listing, fall	2.9	.03	1.00
Listing, spring	50.0	.50	1.00
Harrowing	100.0	1.67	1.67
Pre-emerge	17.6	.18	1.00
Post-emerge	2.9	.03	1.00
Hoeing	100.0	3.00	3.00
Flame cultivation	5.9	.15	2.50
Cultivation	100.0	5.64	5.64
Insecticides	100.0	7.79	7.79
Defoliation	2.9	.03	1.00

[1] Based on 34 observations.

Appendix Table 5. Cotton: Normal yield per acre and production practices, Houston clay, 0-2 percent slope, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	488	488
Pounds of N	100.0	93	93
Pounds of P_2O_5	59.1	25	42
Pounds of K_2O	59.1	25	42
Other practices (times over):			
Flat breaking, fall	13.6	.14	1.00
Middle breaking, fall	86.4	.86	1.00
Middle breaking, spring	86.4	.91	1.05
Discing, fall	13.6	.14	1.00
Discing, spring	13.6	.18	1.33
Listing, spring	9.1	.09	1.00
Harrowing	100.0	1.04	1.04
Pre-emerge	27.3	.27	1.00
Post-emerge	13.6	.23	1.66
Hoeing	100.0	3.59	3.59
Flame cultivation	4.5	.05	1.00
Cultivation	100.0	5.72	5.72
Insecticides	86.4	6.23	7.21

[1] Based on 22 observations.

Appendix Table 6. Cotton: Normal yield per acre and production practices, Houston clay, 2-5 percent slope, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	505	505
Pounds of N	100.0	78	78
Pounds of P_2O_5	75.9	34	45
Pounds of K_2O	75.9	33	44
Other practices (times over):			
Flat breaking, fall	3.4	.03	1.00
Flat breaking, spring	6.9	.07	1.00
Middle breaking, fall	82.8	.86	1.04
Middle breaking, spring	79.3	.90	1.13
Discing, fall	13.8	.17	1.25
Discing, spring	41.4	.65	1.58
Listing, spring	20.7	.21	1.00
Harrowing	100.0	1.31	1.31
Pre-emerge	34.5	.35	1.00
Hoeing	100.0	3.13	3.13
Flame cultivation	6.9	.17	2.50
Cultivation	100.0	5.65	5.65
Insecticides	100.0	6.96	6.96
Defoliation	10.3	.10	1.00

[1] Based on 29 observations.

Appendix Table 7. Cotton: Normal yield per acre and production practices, Houston clay, 2-5 percent slope, eroded, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	508	508
Pounds of N	100.0	87	87
Pounds of P_2O_5	89.3	43	48
Pounds of K_2O	89.3	42	47
Other practices (times over):			
Flat breaking, fall	17.8	.18	1.00
Middle breaking, fall	100.0	1.10	1.10
Middle breaking, spring	71.4	.71	1.00
Discing, fall	25.0	.25	1.00
Discing, spring	14.3	.14	1.00
Listing, spring	10.7	.11	1.00
Harrowing	100.0	.10	1.00
Pre-emerge	21.4	.21	1.00
Post-emerge	14.3	.21	1.50
Hoeing	92.8	3.28	3.53
Flame cultivation	17.8	.43	2.40
Cultivation	100.0	5.64	5.64
Insecticides	100.0	8.32	8.32
Defoliation	7.1	.07	1.00

[1]Based on 28 observations.

Appendix Table 8. Cotton: Normal yield per acre and production practices, Houston silty clay, 2-5 percent slope, eroded, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	662	662
Pounds of N	100.0	64	64
Pounds of P_2O_5	100.0	44	44
Pounds of K_2O	100.0	44	44
Other practices (times over):			
Flat breaking, fall	8.7	.09	1.00
Middle breaking, fall	91.3	1.04	1.14
Middle breaking, spring	13.0	.17	1.33
Discing, fall	56.5	.86	1.53
Discing, spring	39.1	.43	1.11
Listing, fall	4.3	.04	1.00
Listing, spring	73.9	.74	1.00
Harrowing	100.0	1.65	1.65
Pre-emerge	21.7	.22	1.00
Post-emerge	8.7	.09	1.00
Hoeing	95.6	3.21	3.36
Flame cultivation	4.3	.04	1.00
Cultivation	100.0	6.00	6.00
Insecticides	100.0	9.21	9.21
Defoliation	4.3	.04	1.00

[1]Based on 23 observations.

Appendix Table 9. Cotton: Normal yield per acre and production practices, Leeper clay, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	659	659
Pounds of N	100.0	75	75
Pounds of P_2O_5	100.0	46	46
Pounds of K_2O	100.0	46	46
Other practices (times over):			
Flat breaking, fall	7.1	.07	1.00
Middle breaking, fall	78.6	.82	1.04
Middle breaking, spring	85.7	.99	1.16
Discing, fall	3.6	.04	1.00
Discing, spring	100.0	1.82	1.82
Listing, spring	32.1	.39	1.22
Harrowing	100.0	1.75	1.75
Pre-emerge	53.6	.54	1.00
Hoeing	100.0	2.92	2.92
Cultivation	100.0	6.10	6.10
Insecticides	100.0	11.64	11.64
Defoliation	14.3	.14	1.00

[1] Based on 28 observations.

Appendix Table 10. Cotton: Normal yield per acre and production practices, Leeper silty clay, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	621	621
Pounds of N	100.0	64	64
Pounds of P_2O_5	85.7	39	46
Pounds of K_2O	85.7	39	46
Other practices (times over):			
Flat breaking, fall	14.3	.14	1.00
Middle breaking, fall	90.5	1.04	1.15
Middle breaking, spring	38.1	.57	1.50
Discing, fall	19.0	.38	2.00
Discing, spring	61.9	1.03	1.67
Listing, spring	47.6	.48	1.00
Harrowing	100.0	1.57	1.57
Pre-emerge	47.6	.48	1.00
Hoeing	100.0	3.08	3.08
Flame cultivation	4.8	.10	2.00
Cultivation	100.0	5.61	5.61
Insecticides	100.0	8.80	8.80
Defoliation	9.5	.10	1.00

[1] Based on 21 observations.

Appendix Table 11. Cotton: **Normal yield per acre and production practices, Marietta silt loam, moderately shallow, Mississippi Black Belt Area, 1966.**[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	587	587
Pounds of N	100.0	78	78
Pounds of P_2O_5	100.0	50	50
Pounds of K_2O	100.0	50	50
Other practices (times over):			
Flat breaking, fall	13.3	.13	1.00
Middle breaking, fall	40.0	.40	1.00
Middle breaking, spring	100.0	1.53	1.53
Discing, fall	6.7	.07	1.00
Discing, spring	100.0	1.80	1.80
Listing, spring	6.7	.07	1.00
Harrowing	100.0	1.66	1.66
Pre-emerge	40.0	.40	1.00
Hoeing	100.0	3.00	3.00
Cultivation	100.0	5.93	5.93
Insecticides	100.0	12.33	12.33

[1] Based on 15 observations.

Appendix Table 12. Cotton: **Normal yield per acre and production practices, Tuscumbia silty clay, Mississippi Black Belt Area, 1966.**[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	661	661
Pounds of N	100.0	65	65
Pounds of P_2O_5	100.0	47	47
Pounds of K_2O	100.0	47	47
Other practices (times over):			
Middle breaking, fall	100.0	1.08	1.08
Middle breaking, spring	16.7	.17	1.00
Discing, fall	50.0	.58	1.16
Discing, spring	100.0	1.16	1.16
Listing, spring	91.7	1.00	1.09
Harrowing	100.0	1.50	1.50
Pre-emerge	33.3	.33	1.00
Hoeing	100.0	3.25	3.25
Cultivation	100.0	5.50	5.50
Insecticides	100.0	10.58	10.58
Defoliation	8.3	.08	1.00

[1] Based on 12 observations.

Appendix Table 13. Cotton: Normal yield per acre and production practices, Vaiden silt loam, 0-2 percent slope, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	373	373
Pounds of N	100.0	52	52
Pounds of P_2O_5	82.8	28	34
Pounds of K_2O	82.8	27	33
Other practices (times over):			
Flat breaking, fall	3.4	.03	1.00
Middle breaking, fall	65.5	.66	1.00
Middle breaking, spring	82.8	1.04	1.25
Discing, fall	3.4	.03	1.00
Discing, spring	65.5	1.03	1.57
Listing, spring	27.6	.31	1.12
Harrowing	96.6	1.52	1.57
Pre-emerge	6.7	.07	1.00
Hoeing	100.0	3.06	3.06
Cultivation	100.0	5.62	5.62
Insecticides	82.8	4.97	6.00

[1] Based on 29 observations.

Appendix Table 14. Cotton: Normal yield per acre and production practices, Vaiden silt loam, 2-5 percent slope, Mississippi Black Belt Area, 1966.,

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	444	444
Pounds of N	100.0	64	64
Pounds of P_2O_5	91.3	38	42
Pounds of K_2O	91.3	38	42
Other practices (times over):			
Flat breaking, fall	8.7	.09	1.00
Middle breaking, fall	52.2	.52	1.00
Middle breaking, spring	91.3	1.30	1.42
Discing, spring	82.6	1.56	1.89
Listing, spring	26.1	.26	1.00
Harrowing	100.0	1.73	1.73
Pre-emerge	34.8	.35	1.00
Post-emerge	8.7	.09	1.00
Hoeing	100.0	2.69	2.69
Flame cultivation	4.3	.09	2.00
Cultivation	100.0	5.65	5.65
Insecticides	87.0	6.57	7.55

[1] Based on 23 observations.

Appendix Table 15. Cotton: Normal yield per acre and production practices, Vaiden silty clay, 0-2 percent slope, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	439	439
Pounds of N	100.0	50	50
Pounds of P_2O_5	100.0	46	46
Pounds of K_2O	100.0	45	45
Other practices (times over):			
Flat breaking, fall	5.3	.05	1.00
Flat breaking, spring	5.3	.05	1.00
Middle breaking, fall	78.9	.84	1.06
Middle breaking, spring	36.8	.37	1.00
Discing, fall	47.4	.63	1.33
Discing, spring	26.3	.37	1.40
Listing, fall	10.5	.11	1.00
Listing, spring	47.4	.53	1.11
Harrowing	100.0	1.57	1.57
Pre-emerge	10.5	.11	1.00
Post-emerge	5.3	.05	1.00
Hoeing	100.0	2.94	2.94
Cultivation	100.0	5.52	5.52
Insecticides	94.7	6.78	7.16
Defoliation	5.3	.05	1.00

[1]Based on 19 observations.

Appendix Table 16. Cotton: Normal yield per acre and production practices, Vaiden silty clay, 2-5 percent slope, eroded Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	432	432
Pounds of N	97.9	56	57
Pounds of P_2O_5	85.4	33	39
Pounds of K_2O	85.4	32	38
Other practices (times over):			
Middle breaking, fall	81.2	.85	1.05
Middle breaking, spring	47.9	.60	1.26
Discing, fall	8.3	.08	1.00
Discing, spring	75.0	1.04	1.38
Listing, fall	4.2	.04	1.00
Listing, spring	50.0	.50	1.00
Harrowing	100.0	1.68	1.68
Pre-emerge	6.2	.06	1.00
Post-emerge	2.1	.02	1.00
Hoeing	100.0	3.22	3.22
Cultivation	100.0	5.52	5.52
Insecticides	87.5	6.20	7.09

[1]Based on 48 observations.

Appendix Table 17. Cotton: Normal yield per acre and production practices, Vaiden silty clay, 2-5 percent slope, severely eroded, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	422	422
Pounds of N	100.0	59	59
Pounds of P_2O_5	90.0	33	37
Pounds of K_2O	90.0	33	37
Other practices (times over):			
Flat breaking, fall	20.0	.20	1.00
Middle breaking, fall	80.0	.80	1.00
Middle breaking, spring	80.0	1.00	1.25
Discing, fall	20.0	.20	1.00
Discing, spring	70.0	.90	1.28
Listing, spring	20.0	.20	1.00
Harrowing	100.0	1.40	1.40
Pre-emerge	10.0	.10	1.00
Hoeing	100.0	3.00	3.00
Cultivation	100.0	5.90	5.90
Insecticides	100.0	7.30	7.30

[1] Based on 10 observations.

Appendix Table 18. Cotton: Normal yield per acre and production practices, West Point silty clay, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	537	537
Pounds of N	100.0	75	75
Pounds of P_2O_5	68.8	28	40
Pounds of K_2O	68.8	27	39
Other practices (times over):			
Middle breaking, fall	81.2	.84	1.03
Middle breaking, spring	90.6	.96	1.06
Discing, fall	12.5	.13	1.00
Discing, spring	15.6	.16	1.00
Listing, spring	3.1	.03	1.00
Harrowing	100.0	1.12	1.12
Pre-emerge	6.2	.06	1.00
Hoeing	100.0	3.46	3.46
Flame cultivation	6.2	.16	2.50
Cultivation	100.0	6.12	6.12
Insecticides	100.0	7.78	7.78
Defoliation	6.2	.06	1.00

[1] Based on 32 observations.

Appendix Table 19. Cotton: Normal yield per acre and production practices, deep dark upland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	556	556
Pounds of N	100.0	73	73
Pounds of P_2O_5	87.2	38	44
Pounds of K_2O	87.2	37	43
Other practices (times over):			
Flat breaking, fall	6.9	.07	1.00
Flat breaking, spring	2.1	.02	1.00
Middle breaking, fall	86.7	.92	1.06
Middle breaking, spring	56.4	.62	1.10
Discing, fall	30.3	.39	1.29
Discing, spring	41.5	.57	1.38
Listing, fall	2.1	.02	1.00
Listing, spring	42.0	.42	1.00
Harrowing	100.0	1.41	1.41
Pre-emerge	23.9	.24	1.00
Post-emerge	8.5	.12	1.37
Hoeing	98.4	3.22	3.27
Flame cultivation	6.4	.15	2.33
Cultivation	100.0	5.88	5.88
Insecticides	95.7	7.78	8.13
Defoliation	5.8	.06	1.00

[1]Based on 188 observations.

Appendix Table 20. Cotton: Normal yield per acre and production practices, moderately well drained clayey bottomland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	545	545
Pounds of N	99.1	72	73
Pounds of P_2O_5	80.9	34	42
Pounds of K_2O	80.9	34	42
Other practices (times over):			
Flat breaking, fall	4.5	.05	1.00
Flat breaking, spring	1.8	.02	1.00
Middle breaking, fall	70.9	.74	1.05
Middle breaking, spring	80.0	1.00	1.25
Discing, fall	10.9	.11	1.00
Discing, spring	57.3	.96	1.68
Listing, spring	20.0	.21	1.04
Harrowing	100.0	1.43	1.43
Pre-emerge	30.0	.30	1.00
Post-emerge	5.4	.08	1.50
Hoeing	99.1	3.11	3.14
Flame cultivation	2.7	.07	2.66
Cultivation	100.0	5.90	5.90
Insecticides	96.4	8.66	8.98
Defoliation	3.6	.04	1.00

[1]Based on 110 observations.

Appendix Table 21. Cotton: Normal yield per acre and production practices, somewhat poorly drained clayey bottomland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	605	605
Pounds of N	100.0	67	67
Pounds of P_2O_5	94.7	42	44
Pounds of K_2O	94.7	42	44
Other practices (times over):			
Flat breaking, fall	6.4	.06	1.00
Middle breaking, fall	77.6	.82	1.06
Middle breaking, spring	69.1	.87	1.26
Discing, fall	12.8	.18	1.41
Discing, spring	75.5	1.26	1.67
Listing, fall	1.1	.01	1.00
Listing, spring	42.6	.46	1.07
Harrowing	100.0	1.67	1.67
Pre-emerge	37.2	.37	1.00
Post-emerge	1.1	.01	1.00
Hoeing	100.0	3.01	3.01
Flame cultivation	3.2	.07	2.33
Cultivation	100.0	5.77	5.77
Insecticides	100.0	9.37	9.37
Defoliation	7.4	.07	1.00

[1]Based on 94 observations.

Appendix Table 22. Cotton: Normal yield per acre and production practices, Mottled "Postoak" soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yields (lbs. of lint)	100.0	428	428
Pounds of N	99.3	57	57
Pounds of P_2O_5	87.8	35	40
Pounds of K_2O	87.8	34	39
Other practices (times over):			
Flat breaking, fall	5.0	.05	1.00
Flat breaking, spring	.7	.01	1.00
Middle breaking, fall	72.7	.74	1.02
Middle breaking, spring	66.2	.83	1.25
Discing, fall	12.2	.14	1.17
Discing, spring	67.6	1.03	1.52
Listing, fall	2.9	.03	1.00
Listing, spring	38.9	.40	1.03
Harrowing	99.3	1.61	1.62
Pre-emerge	13.7	.14	1.00
Post-emerge	3.6	.04	1.20
Hoeing	100.0	3.02	3.02
Flame cultivation	.7	.01	2.00
Cultivation	100.0	5.58	5.58
Insecticides	88.5	6.35	7.17
Defoliation	.7	.01	1.00

[1]Based on 139 observation.

Appendix Table 23. Cotton: Normal yield per acre and production practices, wet bottomland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (lbs. of lint)	100.0	569	569
Pounds of N	100.0	65	65
Pounds of P_2O_5	96.2	42	44
Pounds of K_2O	96.2	42	44
Other practices (times over):			
Middle breaking, fall	88.5	.92	1.04
Middle breaking, spring	57.7	.77	1.33
Discing, fall	23.1	.27	1.16
Discing, spring	100.0	1.38	1.38
Listing, spring	53.8	.58	1.07
Harrowing	100.0	1.69	1.69
Pre-emerge	26.9	.27	1.00
Hoeing	100.0	3.19	3.19
Cultivation	100.0	5.76	5.76
Insecticides	100.0	10.07	10.07
Defoliation	7.7	.08	1.00

[1] Based on 26 observations.

Appendix Table 24. Corn: Normal yield per acre and production practices, Brooksville silty clay, 0-2 percent slope, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	35	35
Pounds of N	100.0	43	43
Pounds of P_2O_5	27.3	10	37
Pounds of K_2O	27.3	8	31
Other practices (times over):			
Middle breaking, fall	54.5	.55	1.00
Middle breaking, spring	72.7	1.00	1.37
Discing, fall	27.3	.36	1.33
Discing, spring	72.7	.91	1.25
Listing, spring	36.4	.36	1.00
Harrowing	100.0	1.81	1.81
Hoeing and thinning	72.7	.73	1.00
Cultivation	100.0	3.00	3.00

[1] Based on 11 observations.

Appendix Table 25. Corn: Normal yield per acre and production practices, Brooksville silty clay, 2-5 percent slope, eroded, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	34	34
Pounds of N	94.7	48	51
Pounds of P_2O_5	31.6	13	41
Pounds of K_2O	31.6	13	41
Other practices (times over):			
Flat breaking, spring	5.3	.05	1.00
Middle breaking, fall	89.5	.90	1.00
Middle breaking, spring	36.8	.42	1.14
Discing, fall	36.8	.42	1.14
Discing, spring	68.4	.94	1.38
Listing, spring	52.6	.53	1.00
Harrowing	100.0	1.42	1.42
Pre-emerge	5.3	.05	1.00
Hoeing and thinning	47.4	.47	1.00
Cultivation	100.0	2.84	2.84

[1] Based on 19 observations.

Appendix Table 26. Corn: Normal yield per acre and production practices, Catalpa silty clay, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	41	41
Pounds of N	86.7	45	52
Pounds of P_2O_5	24.4	10	43
Pounds of K_2O	24.4	10	43
Other practices (times over):			
Flat breaking, fall	8.9	.09	1.00
Flat breaking, spring	4.4	.04	1.00
Middle breaking, fall	60.0	.64	1.07
Middle breaking, spring	73.3	.95	1.30
Discing, fall	11.1	.13	1.20
Discing, spring	62.2	1.06	1.71
Listing, spring	24.4	.27	1.09
Harrowing	100.0	1.60	1.60
Pre-emerge	4.4	.04	1.00
Post-emerge	2.2	.02	1.00
Hoeing and thinning	51.1	.51	1.00
Cultivation	100.0	3.08	3.08

[1] Based on 45 observations.

Appendix Table 27. Corn: Normal yield per acre and production practices, Houlka silty clay, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	46	46
Pounds of N	100.0	62	62
Pounds of P_2O_5	40.7	15	36
Pounds of K_2O	40.7	14	34
Other practices (times over):			
Flat breaking, spring	7.4	.07	1.00
Middle breaking, fall	88.9	.96	1.08
Middle breaking, spring	55.6	.59	1.06
Discing, fall	22.2	.30	1.33
Discing, spring	44.4	.67	1.50
Listing, spring	44.4	.48	1.08
Harrowing	96.3	1.67	1.73
Pre-emerge	3.7	.04	1.00
Hoeing and thinning	44.4	.44	1.00
Cultivation	100.0	3.03	3.03

[1] Based on 27 observations.

Appendix Table 28. Corn: Normal yield per acre and production practices, Houston clay, 2-5 percent slope, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	33	33
Pounds of N	100.0	48	48
Pounds of P_2O_5	15.4	4	28
Pounds of K_2O	15.4	4	28
Other practices (times over):			
Middle breaking, fall	84.6	1.00	1.18
Middle breaking, spring	69.2	.84	1.22
Discing, fall	7.7	.08	1.00
Discing, spring	38.5	.69	1.80
Harrowing	100.0	1.23	1.23
Hoeing and thinning	76.9	.91	1.18
Cultivation	100.0	3.00	3.00

[1] Based on 13 observations.

Appendix Table 29. Corn: Normal yield per acre and production practices, Houston silty clay, 0-2 percent slope, eroded, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	37	37
Pounds of N	91.7	63	69
Pounds of P_2O_5	25.0	7	28
Pounds of K_2O	25.0	7	28
Other practices (times over):			
Flat breaking, fall	16.7	.17	1.00
Middle breaking, fall	100.0	1.16	1.16
Middle breaking, spring	58.3	.58	1.00
Discing, fall	41.7	.42	1.00
Discing, spring	25.0	.25	1.00
Listing, spring	8.3	.08	1.00
Harrowing	100.0	1.00	1.00
Pre-emerge	8.3	.08	1.00
Hoeing and thinning	75.0	1.00	1.33
Cultivation	100.0	3.25	3.25

[1] Based on 12 observations.

Appendix Table 30. Corn: Normal yield per acre and production practices, Leeper clay, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	53	53
Pounds of N	100.0	74	74
Pounds of P_2O_5	21.4	7	32
Pounds of K_2O	21.4	7	32
Other practices (times over):			
Flat breaking, fall	7.1	.07	1.00
Middle breaking, fall	64.3	.64	1.00
Middle breaking, spring	78.6	.86	1.09
Discing, spring	100.0	1.78	1.78
Listing, spring	21.4	.21	1.00
Harrowing	100.0	1.35	1.35
Post-emerge	7.1	.07	1.00
Hoeing and thinning	7.1	.07	1.00
Cultivation	100.0	2.78	2.78

[1] Based on 14 observations.

Appendix Table 31. Corn: Normal yield per acre and production practices, Leeper silty clay, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	53	53
Pounds of N	94.1	71	75
Pounds of P_2O_5	17.6	6	35
Pounds of K_2O	17.6	6	35
Other practices (times over):			
Flat breaking, fall	5.9	.06	1.00
Flat breaking, spring	5.9	.06	1.00
Middle breaking, fall	88.2	.88	1.00
Middle breaking, spring	41.2	.47	1.14
Discing, fall	23.5	.41	1.75
Discing, spring	52.9	.53	1.00
Listing, spring	52.9	.53	1.00
Harrowing	100.0	1.47	1.47
Pre-emerge	5.9	.06	1.00
Post-emerge	5.9	.06	1.00
Hoeing and thinning	23.5	.24	1.00
Cultivation	100.0	2.94	2.94

[1] Based on 17 observations.

Appendix Table 32. Corn: Normal yield per acre and production practices, Vaiden silt loam, 0-2 percent slope, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	31	31
Pounds of N	95.6	43	45
Pounds of P_2O_5	47.8	16	33
Pounds of K_2O	47.8	15	31
Other practices (times over):			
Flat breaking, spring	4.3	.04	1.00
Middle breaking, fall	47.8	.48	1.00
Middle breaking, spring	73.9	.86	1.17
Discing, fall	4.3	.04	1.00
Discing, spring	69.6	.91	1.31
Listing, spring	34.8	.35	1.00
Harrowing	100.0	1.43	1.43
Pre-emerge	4.3	.04	1.00
Hoeing and thinning	56.5	.57	1.00
Cultivation	100.0	2.91	2.91

[1] Based on 23 observations.

Appendix Table 33. Corn: Normal yield per acre and production practices, Vaiden silt loam, 2-5 percent slope, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	28	28
Pounds of N	100.0	42	42
Pounds of P_2O_5	40.0	12	30
Pounds of K_2O	40.0	12	30
Other practices (times over):			
Flat breaking, fall	10.0	.10	1.00
Middle breaking, fall	30.0	.30	1.00
Middle breaking, spring	90.0	1.50	1.67
Discing, spring	90.0	1.80	2.00
Listing, spring	20.0	.20	1.00
Harrowing	100.0	1.90	1.90
Pre-emerge	10.0	.10	1.00
Hoeing and thinning	70.0	.70	1.00
Cultivation	100.0	2.90	2.90

[1]Based on 10 observations.

Appendix Table 34. Corn: Normal yield per acre and production practices, Vaiden silty clay, 2-5 percent slope, eroded, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	22	22
Pounds of N	86.7	31	36
Pounds of P_2O_5	20.0	7	36
Pounds of K_2O	20.0	7	36
Other practices (times over):			
Middle breaking, fall	60.0	.60	1.00
Middle breaking, spring	73.3	.93	1.27
Discing, spring	66.7	1.07	1.60
Listing, fall	13.3	.13	1.00
Listing, spring	26.7	.27	1.00
Harrowing	100.0	1.73	1.73
Pre-emerge	6.7	.07	1.00
Hoeing and thinning	80.0	.80	1.00
Cultivation	100.0	3.26	3.26

[1]Based on 15 observations.

Appendix Table 35. Corn: Normal yield per acre and production practices, West Point silty clay, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	46	46
Pounds of N	89.6	66	74
Pounds of P_2O_5	31.0	10	32
Pounds of K_2O	31.0	10	31
Other practices (times over):			
Flat breaking, fall	3.4	.03	1.00
Flat breaking, spring	6.9	.07	1.00
Middle breaking, fall	75.9	.83	1.09
Middle breaking, spring	86.2	1.00	1.16
Discing, fall	13.8	.14	1.00
Discing, spring	34.5	.59	1.70
Listing, spring	6.9	.07	1.00
Harrowing	100.0	1.13	1.13
Pre-emerge	6.9	.07	1.00
Hoeing and thinning	58.6	.59	1.00
Cultivation	100.0	3.03	3.03

[1] Based on 29 observations.

Appendix Table 36. Corn: Normal yield per acre and production practices, deep dark upland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	35	35
Pounds of N	95.8	54	56
Pounds of P_2O_5	28.2	10	37
Pounds of K_2O	28.2	10	36
Other practices (times over):			
Flat breaking, fall	2.8	.03	1.00
Flat breaking, spring	2.8	.03	1.00
Middle breaking, fall	77.5	.83	1.07
Middle breaking, spring	60.6	.72	1.18
Discing, fall	26.8	.31	1.15
Discing, spring	46.5	.65	1.39
Listing, fall	2.8	.03	1.00
Listing, spring	26.8	.27	1.00
Harrowing	100.0	1.39	1.39
Pre-emerge	2.8	.03	1.00
Hoeing and thinning	62.0	.70	1.13
Cultivation	100.0	3.05	3.05

[1] Based on 71 observations.

Appendix Table 37. Corn: Normal yield per acre and production practices, moderately well drained clayey bottomland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	43	43
Pounds of N	88.8	55	62
Pounds of P_2O_5	27.5	10	37
Pounds of K_2O	27.5	10	37
Other practices (times over):			
Flat breaking, fall	7.5	.08	1.00
Flat breaking, spring	5.0	.05	1.00
Middle breaking, fall	65.0	.70	1.07
Middle breaking, spring	80.0	1.00	1.25
Discing, fall	11.2	.12	1.11
Discing, spring	55.0	.95	1.72
Listing, spring	16.2	.17	1.07
Harrowing	100.0	1.42	1.42
Pre-emerge	5.0	.05	1.00
Post-emerge	1.2	.01	1.00
Hoeing and thinning	52.0	.52	1.00
Cultivation	100.0	3.05	3.05

[1] Based on 80 observations.

Appendix Table 38. Corn: Normal yield per acre and production practices, somewhat poorly drained clayey bottomland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	49	49
Pounds of N	98.5	66	67
Pounds of P_2O_5	31.3	11	36
Pounds of K_2O	31.3	11	35
Other practices (times over):			
Flat breaking, fall	4.5	.05	1.00
Flat breaking, spring	4.5	.05	1.00
Middle breaking, fall	80.6	.85	1.05
Middle breaking, spring	58.2	.62	1.07
Discing, fall	17.9	.28	1.58
Discing, spring	59.7	1.03	1.72
Listing, spring	37.3	.40	1.08
Harrowing	97.0	1.48	1.53
Pre-emerge	4.5	.04	1.00
Post-emerge	3.0	.03	1.00
Hoeing and thinning	28.4	.27	.95
Cultivation	100.0	2.97	2.97

[1] Based on 67 observations.

Appendix Table 39. Corn: Normal yield per acre and production practices, mottle "post oak" soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	27	27
Pounds of N	94.2	40	42
Pounds of P_2O_5	38.5	13	34
Pounds of K_2O	38.5	13	33
Other practices (times over):			
Flat breaking, fall	1.9	.02	1.00
Flat breaking, spring	3.8	.04	1.00
Middle breaking, fall	50.0	.50	1.00
Middle breaking, spring	73.1	.96	1.31
Discing, fall	7.7	.10	1.25
Discing, spring	71.2	1.11	1.56
Listing, fall	3.8	.04	1.00
Listing, spring	30.8	.31	1.00
Harrowing	100.0	1.63	1.63
Pre-emerge	7.7	.08	1.00
Hoeing and thinning	67.3	.67	1.00
Cultivation	100.0	3.05	3.05

[1] Based on 52 observations.

Appendix Table 40. Corn: Normal yield per acre and production practices, wet bottomland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	50	50
Pounds of N	92.8	54	58
Pounds of P_2O_5	50.0	16	31
Pounds of K_2O	50.0	16	31
Other practices (times over):			
Middle breaking, fall	64.3	.64	1.00
Middle breaking, spring	57.1	.86	1.50
Discing, fall	7.1	.07	1.00
Discing, spring	100.0	1.42	1.42
Listing, spring	50.0	.57	1.14
Harrowing	100.0	1.42	1.42
Post-emerge	7.1	.07	1.00
Hoeing and thinning	35.7	.35	.98
Cultivation	100.0	2.78	2.78

[1] Based on 14 observations.

Appendix Table 41. Soybeans: Normal yield per acre and production practices, deep dark upland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	27	27
Pounds of N	8.9	1	10
Pounds of P_2O_5	28.9	11	39
Pounds of K_2O	28.9	11	39
Other practices (times over):			
Flat breaking, fall	22.2	.22	1.00
Flat breaking, spring	6.7	.07	1.00
Middle breaking, fall	57.8	.60	1.03
Middle breaking, spring	31.1	.31	1.00
Discing, fall	37.8	.49	1.29
Discing, spring	66.7	1.17	1.76
Listing, spring	31.1	.31	1.00
Harrowing	97.8	1.44	1.47
Pre-emerge	6.7	.07	1.00
Post-emerge	4.4	.04	1.00
Hoeing	6.7	.11	1.66
Cultivation	97.7	2.88	2.95

[1] Based on 45 observations.

Appendix Table 42. Soybeans: Normal yield per acre and production practices, moderately well drained clayey bottomland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	26	26
Pounds of N	10.0	5	47
Pounds of P_2O_5	10.0	6	60
Other practices (times over):			
Flat breaking, fall	13.3	.13	1.00
Flat breaking, spring	3.3	.03	1.00
Middle breaking, fall	50.0	.50	1.00
Middle breaking, spring	76.7	1.00	1.30
Discing, fall	10.0	.10	1.00
Discing, spring	100.0	1.80	1.80
Listing, spring	26.7	.27	1.00
Harrowing	96.7	1.62	1.68
Pre-emerge	23.3	.23	1.00
Cultivation	100.0	3.23	3.23

[1] Based on 30 observations.

Appendix Table 43. Soybeans: Normal yield per acre and production practices, somewhat poorly drained clayey bottomland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	27	27
Pounds of N	2.8	1	40
Pounds of P_2O_5	2.8	1	40
Pounds of K_2O	2.8	1	40
Other practices (times over):			
Flat breaking, fall	8.6	.09	1.00
Middle breaking, fall	74.3	.77	1.03
Middle breaking, spring	74.3	.85	1.15
Discing, fall	8.6	.11	1.33
Discing, spring	91.4	1.74	1.90
Listing, spring	28.6	.31	1.10
Harrowing	100.0	1.71	1.71
Pre-emerge	31.4	.31	1.00
Cultivation	100.0	3.31	3.31

[1] Based on 35 observations.

Appendix Table 44. Soybeans: Normal yield per acre and production practices, mottled "post oak" soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	22	22
Pounds of N	8.3	1	10
Pounds of P_2O_5	16.7	7	39
Pounds of K_2O	16.7	7	39
Other practices (times over):			
Flat breaking, fall	8.3	.08	1.00
Middle breaking, fall	79.2	.91	1.15
Middle breaking, spring	45.8	.58	1.27
Discing, fall	16.7	.17	1.00
Discing, spring	79.2	1.29	1.63
Listing, spring	25.0	.25	1.00
Harrowing	100.0	1.58	1.58
Pre-emerge	4.2	.04	1.00
Cultivation	91.7	3.00	3.27

[1] Based on 24 observations.

Appendix Table 45. Soybeans: Normal yield per acre and production practices, wet bottomland soils, Mississippi Black Belt Area, 1966.[1]

Item	Percentage reporting	Average for all farmers	Average for farmers reporting
Yield (bu.)	100.0	26	26
Pounds of P_2O_5	14.3	6	40
Pounds of K_2O	14.3	6	40
Other practices (times over):			
Flat breaking, fall	7.1	.07	1.00
Middle breaking, fall	85.7	.93	1.08
Middle breaking, spring	57.1	.57	1.00
Discing, fall	14.3	.14	1.00
Discing, spring	100.0	1.71	1.71
Listing, spring	35.7	.36	1.00
Harrowing	100.0	1.50	1.50
Pre-emerge	21.4	.21	1.00
Cultivation	100.0	3.50	3.50

[1] Based on 14 observations.

BULLETIN 732 NOVEMBER, 1966

COSTS AND RETURNS FROM DRYLOT FEEDING OF CATTLE IN MISSISSIPPI

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PREFACE

This bulletin contains estimates of costs and returns from drylot feeding of cattle under several systems. These estimates are based on average prices and upon average rates of production. It should be realized that a very small change in prices or in the average daily gain has a considerable effect upon the profitability of the system.

The facilities described in this bulletin represent somewhat of an ideal situation in that only new, durable structures are considered and the systems are completely automated. Cattle can and are being fed in Mississippi with considerably less investment. The systems described represent the more prevalent types and sizes at the time of the study. An individual interested in constructing a feedlot will find the bulletin a useful guide for explaining some of the more popular systems. However, he would be well advised to visit several lots before making a final decision as to type.

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SUMMARY

The purpose of this study was to estimate costs and returns from drylot feeding of cattle in Mississippi. Capacities of lots considered were for 100, 300, and 500 head at one time. Both conditioning 400-pound steer calves to 715-pound feeders and finishing them to 1040-pound slaughter weights were considered.

In the conditioning process a conventional silage-corn combination ration and a high-energy corn silage ration were considered. For finishing, the conventional silage-corn ration was modified so that the silage was discontinued during the last 60 days. The high-energy silage ration was the same as that for conditioning; a third ration consisted predominantly of corn.

The investment per head for the conditioning phase ranged from $213 for the silage-corn system for the 100-head lot feeding a single batch per year down to $78 for the same feeding system where two batches per year are conditioned in a 500-head lot. Based upon 1960-64 average prices for feeder calves, conditioning costs per head, exclusive of labor, ranged from $135 for the large two-batch high-energy system to $160 for feeding a single batch of 100 on the silage-corn ration.

In the finishing process, investment per head varied from $210 per head feeding silage-corn to a single batch of 100 down to only $47 per head using the corn ration for two batches of 500. Costs of finishing, exclusive of labor, based on 1960-64 prices for feeders varied from $234 per head for the smallest corn enterprise for a single batch to $195 for two batches of 500 in the high-energy silage system.

Based upon the data used in the study, the finishing phase is indicated to be more profitable than is conditioning calves in Mississippi. For a single batch, feeding through the winter seemed to be most profitable for both phases. Even then, the silage-corn ration did not show positive returns for conditioning while the most profitable 500-head lot feeding high-energy silage made only $11 per head exclusive of labor costs. Two consecutively fed batches per year in the conditioning phase did not appear profitable even with the savings from greater use of facilities because of the adverse effect of higher calf prices and lower feeder prices.

Finishing cattle through the winter would have yielded returns per head varying from $12 in the 100-head corn system to $46 in the 500-head high-energy system. Beginning with a second batch in May, returns on the second group would have averaged only $6 per head below those fed in the winter.

All of the estimates presented in this report could be altered considerably if the feeder produced his own corn and charged it to the feeding enterprise at the cost of production, as was done for silage. The absolute dollar returns from a particular ration system should not be the only criterion used to select such a system.

Those individuals who do not have sufficient land or good land for either corn or grain sorghum silage might do better with the corn system. Also, those individuals with limited capital must take capital requirements into consideration. The 715-pound feeder animal may have been grazed to this weight at a cheaper cost than was estimated. However, in each situation the alternative rate of returns, which could have been realized by the producer had he followed a cow-calf system or had row crops must be considered.

Costs and Returns from Drylot Feeding of Cattle in Mississippi

By

WILLIAM G. WALKER and TRAVIS D. PHILLIPS

INTRODUCTION

Mississippi cattlemen, long among the nation's leading producers of feeder calves, are awakening to the possibilities that may lie in finishing these animals for slaughter. Already, many producers are placing their calves on feed at weaning, in lots of 50 to 100 head or so, and conditioning them to "two-way" calves, to be sold either for light-weight slaughter or for further finishing. An even more recent development in the state has been the finishing of these conditioned or "warmed up" animals to slaughter weights of around 1,000 pounds.

Since dry-lot feeding is an enterprise relatively new to the state, many cattlemen will want to take a close look at expected costs and returns associated with various systems of feeding before deviating from their established cow-calf operations. Estimates of per-head costs and returns for several types and sizes of feed-lot operations have recently been developed through research at Mississippi State University. In this report these estimates are presented for:

(a) conditioning 400-pound steer calves to 715-pound feeders; and

(b) finishing 715-pound steers to 1040-pound slaughter weights.

For the calf-conditioning enterprises, both a conventional corn-silage-shelled corn ration and a high-energy silage rations are considered.[1] In the steer-finishing models estimates are developed for three rations: (1) a conventional silage-corn ration to be fed for 100 days and followed by a ration high in corn content for 60 days; (2) a high-energy silage ration identical in composition to that used in calf-conditioning; and (3) a ration consisting mostly of shelled corn and cottonseed hulls.

For each of the five feeding systems above, per-head costs and returns are estimated for enterprises of 100, 300, and 500 head. In addition, the effects of feeding both one and two batches of animals per year are considered. In all, then, estimates for a total of 30 slightly different feed-lot operations are presented.

Data Sources

Information on inputs and practices currently being used was obtained in an extensive survey of cattle-feeders in Mississippi. Costs for the 30 model operations were synthesized from survey data and from information supplied by personnel in various technical departments of the Mississippi Agricultural Experiment Station. Considerable help, particularly on facility requirements, was obtained from research underway in Illinois.[2]

To reduce the effect of short-term price changes, 1960-64 average prices for cattle, and for most feed ingredients except silage, were used in these estimates. For silage, cost-of-production figures based on work previously reported by McReynolds and Hamill[3] were used. Prices of all other input items are representative of those prevailing in the state in 1964. (See Appendix for input price data).

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[1] High-energy silage is corn cut immediately below the ear or grain sorghum cut just under the seed head when the moisture content has become lower than for conventional silage. Research on high-energy silage has been underway for several years at the Mississippi Delta Agricultural Experiment Branch Station at Stoneville.

[2] VanArsdall, Roy N., **Guides for Use in Planning Beef Systems**, Mimeograph release AE-3971, University of Illinois, College of Agriculture, Urbana, Illinois, December 1963. Also, VanArsdall supplied other helpful suggestions through correspondence.

[3] McReynolds, John T., and James G. Hamill, **Budgets for Forage Crops in the Brown Loam Area of Mississippi**, Miss. Agri. Exp. Sta. AEC. M.R. No. 46, August 1965.

Depreciation rates on equipment and facilities were obtained from technical personnel and from the trade. In instances where identical items of equipment are to be used in enterprises of different sizes, these rates are adjusted for changes in amounts of annual use.

COSTS OF CONDITIONING CALVES

The survey of cattle-feeders indicated that most feeders of lighter-weight animals were using rations high in roughage rather than high in corn content. Preliminary analyses show rations of the former type to be the less expensive. For these reasons, only roughage-type rations were considered in developing estimates of costs of conditioning calves.

Rations, Rates of Gain and Facilities

Facilities required were estimated on the assumption that no existing facilities are available for feeding cattle, except possibly lots for working new cattle before they go into the feedlot. Facility requirements for 100-, 300-, and 500-head calf-conditioning enterprises are itemized in Appendix Tables 1 and 2.

Either of the two rations considered for calves was assumed to yield an average daily gain of 1.75 pounds, Tables 1 and 2. With such gain it would take 180 days to bring 400-pound calves to 715-pound weights. Thus, silo capacities are based on an 180-day feeding program. If two batches per year are to be fed, these capacities must be doubled, but no changes need to be made in other facilities.

The feed-lot, paved with 4-inch concrete, allows 70 square-feet of space per animal. A concrete feed bunk, with a 10-foot wide roof, runs down the center. Fences are of creosote post-steel cable construction. An automatic feeding system augers out all feed.

Silos, of the concrete stave type, are equipped with unloaders. Storage facilities for shelled corn, where needed, are sufficiently large to hold a truckload or more. Where dry grain rations are to be used, a hammer mill and feed mixer are included.

The lists of facilities shown in the appendix tables include a deep well and pump. In many instances, however, the farm's existing water system may be adequate to supply the additional water needed. In fact, all facility requirements are based on general recommendations and may be adjusted for particular farm situations.

Table 1. Silage-corn ration: Average daily feed requirements and costs for a 400 lb. calf to gain 315 lbs. at an average rate of 1.75 lb. per day.

Kind of feed	Quantity of feed	Cost per day
	pounds	cents
Corn silage		
As silage	(27.00)	(7.83)[1]
Hay equiv.	9.00	7.83
Shelled corn	6.00	14.25
Ground limestone	.22	.22
Urea	.22	1.10
Deflourinated phosphate	0.14	0.43
Mineralized salt	0.08	0.22
Vitamin A premix	+	0.20
Antibiotic	+	0.63
Total	15.66	24.88
Feed cost per lb. of gain		14.22

Source: Adapted from Subcommittee on Beef Cattle Nutrition, **Nutrient Requirements of Domestic Animals, No. IV,** Nutrient Requirements of Beef Cattle, Revised Edition, Publication 1137, National Academy of Science — National Research Council, Washington, 1963.

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[1] Due to an 8% loss in storage, 2174 pounds of silage should be produced for each ton fed. Therefore, one pound of silage at feeding time cost 0.29 cents (Appendix Table 7).

Table 2. High-energy corn silage ration: Average daily feed requirements and costs for a 400 lb. calf to gain 315 lbs. at an average rate of 1.75 lb. per day.[1]

Kind of feed	Amount	Cost per day
	pounds	cents
High-energy corn silage	43.00	15.91[2]
Urea	0.22	1.10
Ground limestone	0.22	0.22
Mineralized salt	0.08	0.22
Antibiotic	+	0.63
Total		18.08
Feed cost per lb. of gain		10.33

Source: Adapted from Subcommittee on Beef Cattle Nutrition, **Nutrient Requirements of Domestic Animals, No. IV,** Nutrient Requirements of Beef Cattle, Revised Edition, Publication 1137, National Academy of Science — National Research Council, Washington, 1963.

[1] Usually cut just below the ear with a conventional silage harvester of which the cutter bar with some modification can be raised 24 to 30 inches above the ground.

[2] Due to an 8% loss in storage, 2174 pounds of silage should be produced for each ton fed. Therefore, one pound of silage at feeding time costs 0.37 cents (Appendix Table 7).

For example, it may be practical in some instances to eliminate the concrete slab, or to concrete only an area around the feed bunk. Generally, however, the less concrete, the more land is required for the feed-lot. Again, in place of an automatic feeding system, a fence-line feed bunk is often used for feeding from either upright or trench silos.

Investment

A 100-calf capacity system designed for use of a conventional silage-dry corn ration would require a larger investment in facilities than would one of the same size planned for use of high-energy silage. This difference occurs mainly because of the extra facilities needed for storing and handling dry feeds. With only minor additions, however, these dry-feed facilities would be sufficient to handle feed for up to 500 head. For that reason the larger enterprises, where conventional silage is to be fed, require less investment than do those of the high-energy silage type.

At the 1964 level of prices, facility investments in conventional silage feed-lot systems designed for one batch of animals a year would range from $21,256 for a 100-head system to $62,493 for a 500-head capacity lot, Table 3. Thus, investment per head would average $213 for the smaller enterprise and $125 for the largest considered. Feeding two batches of calves per year would drop these averages to $134 and $78, respectively.

For the high-energy silage system, investment requirements range from $19,041 for 100 head to $69,547 for 500 head, if only one batch a year is fed, Table 4. Feeding two batches a year would drop the per-head average investment from $190 to $128 in a 100-head operation, and from $139 to $96 in a 500-head one.

Costs

In estimating costs of feeding cattle two kinds of costs must be considered: annual investment costs—or depreciation and interest on investment—and out-of-pocket operational costs.

In developing estimates of operational costs, calves going into the feed-lot were priced at $21.68 per hundredweight, the 1960-64 average price for 400-pound steer calves at Memphis. Price quotations for comparable animals sold in Mississippi during the period were not available, since the Market News Service does not report sales from Mississippi markets.

Daily feed costs per animal for the conventional silage-corn ration were estimated at about 25 cents, Table 1. Corresponding costs for the high-energy silage ration was considerably lower, Table 2. In developing these costs, an acre of silage was considered to cost $81.17 to produce and to yield 15 tons of conventional or 12 tons of high-energy silage, Appendix Table 7. All costs of production are included so that the $5.41 per ton for conventional and $6.76 for high-energy silage rep-

Table 3. Investment in facilities and equipment for feeding 400 lb. calves to 715 lb. yearlings, 180 days on a silage-corn ration, by size of enterprise and number of batches fed per year, Mississippi, 1964.

Item	No. fed per batch					
	100		300		500	
	(1 batch)	(2 batches)	(1 batch)	(2 batches)	(1 batch)	(2 batches)
	dollars					
Land	100	100	100	100	200	200
Lot, shelter and buildings						
Concrete lot, feed bunk and fence	2,943	2,943	8,148	8,148	13,611	13,611
Cattle shed	4,200	4,200	12,600	12,600	21,000	21,000
Feed room	384	384	384	384	384	384
Feed storage						
Shelled corn	394	394	394	394	394	394
Corn silage	5,450	10,900	11,000	22,000	15,500	31,000
Mixed ration	226	226	226	226	226	226
Feed handling and processing equipment						
Hammer mill, feed mixer and feed meters	1,891	1,891	1,891	1,891	1,891	1,891
Auger feeder	558	558	1,458	1,458	3,096	3,096
Screw augers	854	854	854	854	935	935
Silage blower	900	900	900	900	900	900
Water system						
Deep well, pump and 120-gal. tank[1]	1,062	1,062	1,062	1,062	1,062	1,062
3/4" pipe and waterers	326	326	658	658	1,326	1,326
Manure handling equipment						
Front-end loader	468	468	468	468	468	468
Manure spreader	700	700	700	700	700	700
Miscellaneous equipment						
Scales and shelter	600	600	600	600	600	600
Headgate and chute	200	200	200	200	200	200
Total investment	21,256	26,706	41,643	52,643	62,493	77,993
Investment/head	213	134	139	88	125	78

[1] Adapted from Jacks, Barney H. and Phillips, Travis D., **Costs of Producing Hogs in Confinement,** Bulletin 628, Mississippi Agricultural Experiment Station, State College, Mississippi, October, 1961. Includes 300 feet of drilling and casing.

Table 4. Investment in facilities and equipment for feeding 400 lb. calves to 715 lb. yearlings, 180 days on a silage-corn ration, by size of enterprise and number of batches fed per year, Mississippi, 1964.

Item	No. fed per batch					
	100		300		500	
	(1 batch)	(2 batches)	(1 batch)	(2 batches)	(1 batch)	(2 batches)
	dollars					
Land	100	100	100	100	200	200
Lot, shelter and buildings						
Concrete lot, feed bunk and fence	2,943	2,943	8,148	8,148	13,611	13,611
Cattle shed	4,200	4,200	12,600	12,600	21,000	21,000
Feed room	384	384	384	384	384	384
Feed storage						
Corn silage	6,600	13,200	15,500	31,000	26,000	52,000
Feed handling equipment						
Auger feeder	558	558	1,458	1,458	3,096	3,096
Silage blower	900	900	900	900	900	900
Water system						
Deep well, pump and 120-gal. tank[1]	1,062	1,062	1,062	1,062	1,062	1,062
3/4" pipe and waterers	326	326	658	658	1,326	1,326
Manure handling equipment						
Front-end loader	468	468	468	468	468	468
Manure spreader	700	700	700	700	700	700
Miscellaneous equipment						
Scales and shelter	600	600	600	600	600	600
Headgate and chute	200	200	200	200	200	200
Total investment	19,041	25,641	42,778	58,278	69,547	95,547
Investment/head	190	128	143	97	139	96

[1] Adapted from Jacks, Barney H. and Phillips, Travis D., **Costs of Producing Hogs in Confinement,** Bulletin 628, Mississippi Agricultural Experiment Station, State College, Mississippi, October, 1961. Includes 300 feet of drilling and casing.

resent the cost of silage ready to be blown into the silo. Actually, some economies are associated with size, depending upon the usage of specialized harvesting equipment.

Veterinary and medical costs include veterinary services, medicines and parasite control, and stilbestrol at the rate of two implants per animal. Electricity cost was computed by applying Tennessee Valley Authority's residential rates to the estimated number of kilowatt-hours consumed by the enterprise.

Estimates of labor costs include charges for time spent in buying and selling cattle, receiving them, care of sick animals, checking cattle, cleaning pens, grinding and mixing feed, feeding with mechanical feeders, and loading out cattle. Grinding and mixing feed, feeding, and cleaning pens require approximately 80 percent of the labor in both feeding systems. Feed handling and processing is semi-automated.

One man should be able to handle any of the enterprises considered, with additional labor needed only for receiving and loading out cattle. Should the operator do the work himself, or if labor is available at no additional cost, returns from the sale of cattle would include a return for his labor. If labor must be hired, however, it then becomes an operating cost. For these reasons, charges for labor are separated from other specified operating cost shown below, but are included in the estimates of total and per-head costs. In all cost comparisons below, the per-head costs used are those that exclude labor, as shown in the bottom row of the cost tables for the respective systems.

Estimated costs per head of conditioning calves with the conventional silage-corn ration range from $160 in a 100-head enterprise to $151 in a 500-head operation, when only one batch a year

Table 5. Costs of feeding 400 lb. calves to 715 lb. yearlings, 180 days on a silage-corn ration, by size of enterprise and number of batches fed per year, Mississippi, 1964.

Item	No. fed per batch					
	100		300		500	
	(1 batch)	(2 batches)	(1 batch)	(2 batches)	(1 batch)	(2 batches)
	dollars					
Investment Costs:						
Depreciation:						
Lot, shelter and buildings	301	301	845	845	1,399	1,399
Feed storage	248	466	470	910	651	1,271
Feed handling and processing equipment	273	370	403	664	667	1,001
Water system	138	138	170	170	235	235
Manure handling equipt.	58	70	76	140	117	175
Miscellaneous equipment	50	50	50	50	50	50
Interest [1]	534	670	1,044	1,319	1,567	1,955
Total	1,602	2,065	3,058	4,098	4,686	6,086
Operating Costs:						
Cattle	8,672	17,344	26,016	52,032	43,360	86,720
Feed	4,479	8,958	13,437	20,874	22,395	44,790
Vet. and medicine	125	250	375	750	625	1,250
Repairs	767	1,029	1,606	2,180	2,496	3,276
Electricity	11	22	26	52	58	116
Interest on operating capital [2]	386	773	1,137	2,244	1,889	3,731
Total	14,440	28,376	42,597	84,132	70,823	139,883
Total specified costs	16,042	30,441	45,655	88,230	75,509	145,969
Labor [3]	275	550	820	1,640	1,369	2,738
Total cost	16,317	80,911	46,475	89,870	76,878	148,707
Per head:						
With labor	163	155	155	150	154	149
Without labor	160	152	152	147	151	146

[1] 5% on average investment including land.

[2] 5% for one year on silage, limestone, and urea; 5% for ½ year on all other items making up operating costs.

[3] Adapted from Johnson, R. G. Nodland, T. R., **Labor Used in Cattle Feeding,** Bulletin 451, Minnesota Agricultural Experiment Station, St. Paul, Minnesota, March, 1960; Williams, Willard F. and McDowell, James I., **Costs and Efficiency in Commercial Dry-Lot Cattle Feeding,** processed series, P-509, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma, June, 1965.

is fed, Table 5. Thus, on a hundredweight basis the respective feed-lot operators would have $22.37 and $21.12 invested in the conditioned calves. Feeding two batches per year would reduce costs in the 100-head operation by $8 per head, and in the 500-head system by $5 per head.

In the high-energy silage system, per-head cost estimates for one-batch operations vary from $140 to $145, Table 6. Per hundredweight, these costs are $19.58 and $20.28. Feeding a second batch would reduce per-head costs by $7 in the smallest operation and by $4 to $5 in the larger ones.

In summary, it appears that costs of conditioning calves on high-energy silage average about 8 to 9 percent below those in similar enterprises using a conventional silage-corn ration.

Transportation Rates

Costs of transporting cattle are not included in the estimates shown above since these costs vary with the method of transportation and the distance cattle are hauled. The feed-lot operator must, however, consider any costs he must bear for transporting cattle to and from the feed-lot. To aid him in doing so the following estimates of prevailing truck rates are given:

A two and one-half ton truck with a capacity of 17 to 20 400-pound calves or 11 to 14 715-pound steers would cost an estimated 30 cents per loaded mile. A large single-deck trailer with a capacity of 50 400-pound calves or 40 715-pound steers would cost 45 cents per loaded mile. A large double-deck trailer hauling 85 to 95 400-pound calves or 60 to 70 steers weighing 715 pounds would cost 60 cents per loaded mile.

Table 6. Costs of feeding 400 lb. calves to 715 lb. yearlings, 180 days on a high-energy corn silage ration, by size of enterprise and number of batches fed per year, Mississippi, 1964.

Item	No. fed per batch					
	100		300		500	
	(1 batch)	(2 batches)	(1 batch)	(2 batches)	(1 batch)	(2 batches)
	dollars					
Investment Costs:						
Depreciation:						
Lot, shelter and buildings	301	301	845	845	1,399	1,399
Feed storage	264	528	620	1,240	1,040	2,080
Feed handling equipment	93	129	194	309	385	577
Water system	138	138	170	170	235	235
Manure handling equipt.	58	70	76	140	117	175
Miscellaneous equipment	50	50	50	50	50	50
Interest[1]	479	644	1,172	1,560	1,744	2,394
Total	1,383	1,860	3,127	4,314	4,970	6,910
Operating Costs:						
Cattle	8,672	17,344	26,016	52,032	43,360	86,720
Feed	3,254	6,508	9,762	19,524	16,270	32,540
Vet. and medicine	125	250	375	750	625	1,250
Repairs	716	1,000	1,678	2,373	2,778	3,921
Electricity	11	22	26	52	58	116
Interest on operating capital[2]	351	686	1,040	2,053	1,733	3,422
Total	13,129	25,810	38,897	76,784	64,824	127,969
Total specified costs	14,512	27,670	42,024	81,098	69,794	134,879
Labor[3]	250	500	715	1,430	1,195	2,390
Total costs	14,762	28,170	42,739	82,528	70,989	137,269
Per head:						
With labor	148	141	142	138	142	137
Without labor	145	138	140	135	140	135

[1] 5% on average investment including land.

[2] 5% for one year on feed; 5% for ½ year on all other items making up operating costs.

[3] Adopted from Johnson, R. G. and Nodland, T. R., **Labor Used in Cattle Feeding**, Bulletin 451, Minnesota Agricultural Experiment Station, St. Paul, Minnesota, March, 1960; Williams, Willard F. and McDowell, James I., **Costs and Efficiency in Commercial Dry-Lot Cattle Feeding**, processed series P-509, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma, June, 1965.

COSTS OF FINISHING STEERS

Finishing operations considered here consist of feeding either one or two batches of heavy feeder steers to slaughter weights of 1040 pounds. A variation not considered was the finishing of one batch of steers and the conditioning of a batch of calves. Such operation would necessitate some modification in feed storage capacity.

Rations, Rates of Gain and Facilities

In the model designed for use of conventional silage the ration is similar to that used for conditioning younger animals, except that for the last 60 days of feeding silage is discontinued and the amount of corn fed per day is more than doubled, Tables 1, 7. This ration is expected to produce average daily gains of 1.75 during the 100 days of silage-corn feeding and 2.50 pounds during the period of heavy corn feeding. With such gains, and at 1964 prices, costs of the ration would run about 35 to 36 cents per animal day, or an estimated 17.49 cents per pound of gain. Facility requirements for such system are itemized in Appendix Table 3. If two lots of steers a year are to be finished, the silo capacities shown in that table must be doubled.

The high-energy silage ration for steers is the same as for calves, except that larger quantities of silage are fed daily, Tables 2, 8. At an average daily gain of 2.0 pounds, steers would need 162 days on this ration to gain 325 pounds. Feed costs per pound of gain would run slightly more than 11 cents. Facilities required for this system would be the same as for conditioning with high-energy silage, except for more silage capacity, Appendix Tables 2, 4.

On a predominantly corn ration, Table 9, steers could be expected to gain 325 pounds in 141 days, or at a rate of 2.3 pounds per day. Facilities for this ration are described in Appendix Table 5.

Table 7. Silage-corn and corn ration; Average daily requirements and costs for a 715 lb. yearling to gain 1.75 lb. per day for 100 days on silage-corn and 2.5 lbs. per day for the next 60 days on corn.

Kind of feed	Quantity of feed	Cost per day
	pounds	cents
Silage-corn (100 days)		
Corn silage		
As silage	(39.00)	(11.31)[1]
Hay equivalent	13.00	11.31
Shelled corn	6.00	14.25
Ground limestone	0.22	0.22
Urea	0.22	1.10
Deflourinated phosphate	0.14	0.43
Mineralized salt	0.08	0.22
Vitamin A premix	+	0.20
Antibiotic	+	0.63
Total	19.66	28.36
Feed cost per lb. of gain		16.21
Corn (60 days)		
Shelled corn	16.50	39.19
Cottonseed hulls	3.74	3.74
Cottonseed meal	.51	1.78
Urea	.25	1.25
Salt	.10	.28
Deflourinated phosphate	.13	.40
Vitamin A premix	+	.20
Antibiotic	+	.63
Total	21.23	47.47
Feed cost per lb. of gain		18.99
Average feed cost per lb. of gain		17.49

Source: Adapted from Subcommittee on Beef Cattle Nutrition, **Nutrient Requirements of Domestic Animals, No. IV,** Nutrient Requirements of Beef Cattle, Revised Edition, Publication 1137, National Academy of Science, National Research Council, Washington, 1963.

[1] Due to an 8% loss in storage, 2174 pounds of silage should be produced for each ton fed. Therefore, one pound of silage at feeding time costs 0.29 cents (Appendix Table 7).

Table 8. High-energy corn silage ration: Average daily feed requirements and costs for a 715 lb. yearling to gain 325 lbs. at an average rate of 2.0 lbs. per day.[1]

Kind of feed	Quantity of feed	Cost per day
	pounds	cents
High-energy corn silage	54.00	19.98[2]
Urea	0.22	1.10
Ground limestone	0.22	0.22
Mineralized salt	0.08	0.22
Antibiotic	+	0.63
Total	54.52	22.15
Feed cost per lb. of gain		11.08

Source: Adapted from Subcommittee on Beef Cattle Nutrition, **Nutrient Requirements of Domestic Animals, No. IV**, Nutrient Requirements of Beef Cattle, Revised Edition, Publication 1137, National Academy of Science - National Research Council, Washington, 1963.

[1] Usually cut just below the ear with a conventional silage harvester of which the cutter bar with some modification can be raised 24 to 30 inches above the ground.

[2] Due to an 8% loss in storage, 2174 pounds of silage should be produced for each ton fed. Therefore, one pound of silage at feeding time costs 0.37 cents (Appendix Table 7).

Investment

Since the major differences in facilities for the various silage-using models are in silo capacities, cattle-finishing facilities for systems of that type would cost about the same to construct as would calf-conditioning facilities of comparable sizes. Per-head investments are estimated at $75 to $210, depending upon the kind of silage to be used and the number of steers to be finished annually, Tables 10, 11.

Systems designed for use of shell corn rations require no silos, and thus can be constructed at considerably less cost than can comparable silage-using systems, Table 12. Year-round operations would lower average investment to about 80 percent of the amounts shown in the table for two-batch operations, since, on the corn ration, two and one-half batches could be finished in a year.

Costs

Feeder steers going into the feed-lots were priced at $19.82 per hundredweight, the 5-year (1960-64) average of price quotations for standard and good feeder steers at Memphis, Appendix Table 10. That price is considerably lower than either the $20.00 to $23.08 costs reported earlier for conditioning feeders or the over-all average of $20.04 that Mississippi farmers received for steers and heifers during the 1960-64 period. Yet there is ample justification for pricing the steers at average market value.

Costs of other inputs were estimated in the same manner as were costs for the conditioning phase.

In the single-batch, conventional silage system estimated costs per steer finished range from $229 in a 100-head operation to $219 in a 500-head enter-

Table 9. Corn ration: Average daily feed requirements and costs for a 715 lb. yearling to gain 325 lbs. at an average rate of 2.3 lbs. per day.

Kind of feed	Quantity of feed	Cost per day
	pounds	cents
Shelled corn	16.50	39.19
Cottonseed hulls	3.74	3.74
Cottonseed meal	.51	1.78
Urea	.25	1.25
Mineralized salt	.10	.28
Deflourinated phosphate	.13	.40
Vitamin A premix	+	.20
Antibiotic	+	.63
Total	21.23	47.47
Feed cost per lb. of gain		20.64

Source: Adapted from Subcommittee on Beef Cattle Nutrition, **Nutrient Requirements of Domestic Animals, No. IV**, Nutrient Requirements of Beef Cattle, Revised Edition, Publication 1137, National Academy of Science - National Research Council, Washington, 1963.

Table 10. Investment in facilities and equipment for feeding 715 lb. yearlings to 1040 lb. slaughter cattle, 100 days on a silage-corn ration followed by 60 days on a corn ration, by size of enterprise and number of batches fed per year, Mississippi, 1964.

Item	No. fed per batch					
	100		300		500	
	(1 batch)	(2 batches)	(1 batch)	(2 batches)	(1 batch)	(2 batches)
	dollars					
Land	100	100	100	100	200	200
Lot, shelter and buildings						
Concrete lot, feed bunk and fence	2,943	2,943	8,148	8,148	13,611	13,611
Cattle shed	4,200	4,200	12,600	12,600	21,000	21,000
Feed room	384	384	384	384	384	384
Feed storage						
Shelled corn	394	394	394	394	394	394
Corn silage	4,850	9,700	9,500	19,000	13,500	27,000
Cottonseed hulls	394	394	536	536	536	536
Mixed ration	226	226	226	226	226	226
Feed handling and processing equipment						
Hammer mill, feed mixer andd feed meters	1,891	1,891	1,891	1,891	1,891	1,891
Auger feeder	558	558	1,458	1,458	3,096	3,096
Screw augers	854	854	854	854	935	935
Silage blower	900	900	900	900	900	900
Water system						
Deep well, pump and 120-gal. tank[1]	1,062	1,062	1,062	1,062	1,062	1,062
3/4" pipe and waterers	326	326	658	658	1,326	1,326
Manure handling equipment						
Front-end loader	468	468	468	468	468	468
Manure spreader	700	700	700	700	700	700
Miscellaneous equipment						
Scales and shelter	600	600	600	600	600	600
Headgate and chute	200	200	200	200	200	200
Total investment	21,050	25,900	40,679	50,179	61,029	74,529
Investment/head	210	130	136	84	122	75

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[1] adapted from Jacks, Barney H., and Phillips, Travis D., **Costs of Producing Hogs in Confinement**, Bulletin 628, Mississippi Agricultural Experiment Station, State College, Mississippi, October, 1961. Includes 300 feet of drilling and casing.

Table 11. Investment in facilities and equipment for feeding 715 lb. yearlings to 1040 lb. slaughter cattle, 162 days on a high-energy corn silage ration, by size of enterprise and number of batches fed per year, Mississippi, 1964.

Item	No. fed per batch					
	100		300		500	
	(1 batch)	(2 batches)	(1 batch)	(2 batches)	(1 batch)	(2 batches)
	dollars					
Land	100	100	100	100	200	200
Lot, shelter and buildings						
Concrete lot, feed bunk and fence	2,943	2,943	8,148	8,148	13,611	13,611
Cattle shed	4,200	4,200	12,600	12,600	21,000	21,000
Feed room	384	384	384	384	384	384
Feed storage						
Corn silage	7,300	14,600	19,720	39,440	28,500	57,000
Feed handling equipment						
Auger feeder	558	558	1,458	1,458	3,096	3,096
Silage blower	900	900	900	900	900	900
Water system						
Deep well, pump and 120-gal. tank[1]	1,062	1,062	1,062	1,062	1,062	1,062
3/4" pipe and waterers	326	326	658	658	1,326	1,326
Manure handling equipment						
Front-end loader	468	468	468	468	468	468
Manure spreader	700	700	700	700	700	700
Miscellaneous equipment						
Scales and shelter	600	600	600	600	600	600
Headgate and chute	200	200	200	200	200	200
Total investment	19,741	27,041	46,998	66,718	72,047	100,547
Investment/head	197	135	157	111	144	101

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[1] adapted from Jacks, Barney H., and Phillips, Travis D., **Costs of Producing Hogs in Confinement**, Bulletin 628, Mississippi Agricultural Experiment Station, State College, Mississippi, October, 1961. Includes 300 feet of drilling and casing.

Table 12. Investment in facilities and equipment for feeding 715 lb. yearlings to 1040 lb. slaughter cattle, 141 days on a corn ration, by sizes of enterprise and number of batches fed per year, Mississippi, 1964.

Item	No. fed per batch					
	100		300		500	
	(1 batch)	(2 batches)	(1 batch)	(2 batches)	(1 batch)	(2 batches)
	dollars					
Land	100	100	100	100	200	200
Lot, shelter and buildings						
Concrete lot, feed bunk and fence	2,943	2,943	8,148	8,148	13,611	13,611
Cattle shed	4,200	4,200	12,600	12,600	21,000	21,000
Feed room	384	384	384	384	384	384
Feed storage						
Shelled corn	394	394	394	394	394	394
Cottonseed hulls	536	536	536	536	536	536
Mixed ration	226	226	394	394	394	394
Cottonseed meal	226	226	226	226	226	226
Feed handling and processing equipment						
Hammer mill, feed mixer and feed meters	1,891	1,891	1,891	1,891	1,891	1,891
Auger feeder	558	558	1,458	1,458	3,096	3,096
Screw augers	854	854	854	854	935	935
Water system						
Deep well, pump and 120-gal. tank[1]	1,062	1,062	1,062	1,062	1,062	1,062
3/4" pipe and waterers	326	326	658	658	1,326	1,326
Manure handling equipment						
Front-end loader	468	468	468	468	468	468
Manure spreader	700	700	700	700	700	700
Miscellaneous equipment						
Scales and shelter	600	600	600	600	600	600
Headgate and chute	200	200	200	200	200	200
Total investment	15,668	15,668	30,673	30,673	47,023	47,023
Investment/head	157	78	103	52	95	47

[1] adapted from Jacks, Barney H., and Phillips, Travis D., **Costs of Producing Hogs in Confinement,** Bulletin 628, Mississippi Agricultural Experiment Station, State College, Mississippi, October, 1961. Includes 300 feet of drilling and casing.

prise. Per hundredweight, these costs become $22.02 and $21.06. Feeding two batches per year would lower costs by $9 per head in the smallest lot and by $5 per head in the largest, Table 13.

High-energy silage systems gave the lowest average costs of the three, with costs per head in those systems running $19 to $23 below those in corresponding conventional silage systems, Table 14.

With corn priced at $1.33, costs in systems using the shelled corn ration average $26 to $28 per head higher than those in the high-energy silage systems, Table 15. If the feeder can produce corn for less than $1.33 per bushel, and if corn were charged to the feeding enterprise at cost of production, per-head costs in these systems might be lowered considerably. To a lesser extent, using home-produced corn could also reduce costs in the systems using a conventional silage-corn ration.

Transportation Rates

As is the case in calf-conditioning operations, transportation costs borne by the feeder must be added to costs of finishing. Estimates of rates for feeder steers were given earlier. From the same sources, the following estimates are given: Rates on a two and one-half ton truck, hauling 8 to 10 1040 pound steers, are 30 cents per loaded mile; on a single deck trailer, with a capacity of 25 to 30 steers, 40 cents per loaded mile; and on a double-deck trailer hauling 40 to 45 steers, 60 cents per loaded mile.

Table 13. Costs of feeding 715 lb. yearlings to 1040 lb. slaughter cattle, 100 days on a silage-corn ration followed by 60 days on a corn ration, by size of enterprise and number of batches fed per year, Mississippi, 1964.

Item	No. fed per batch					
	100		300		500	
	(1 batch)	(2 batches)	(1 batch)	(2 batches)	(1 batch)	(2 batches)
Investment Costs:			dollars			
Depreciation:						
Lot, shelter & buildings	301	301	845	845	1,399	1,399
Feed storage	245	439	438	818	593	1,133
Feed handling and processing equipment	273	370	403	664	659	1,001
Water system	138	138	170	170	234	234
Manure handling equip.	58	70	76	140	117	175
Miscellaneous equipment	50	50	50	50	50	50
Interest [1]	529	650	1,019	1,257	1,531	1,869
Total	1,594	2,018	3,001	3,944	4,583	5,861
Operating Costs:						
Cattle	14,171	28,342	42,513	85,026	70,855	141,710
Feed	5,684	11,368	17,052	34,104	28,420	56,840
Vet. and medicine	125	250	375	750	625	1,250
Repairs	759	997	1,568	2,081	2,437	3,143
Electricity	10	20	23	46	52	104
Interest on operating capital [2]	546	1,076	1,617	3,203	2,688	5,329
Total	21,295	42,053	63,148	125,210	105,077	208,376
Total specified costs	22,889	44,071	66,149	129,154	109,660	214,237
Labor [3]	268	536	820	1,640	1,340	2,680
Total costs	23,157	44,607	66,969	130,794	111,000	216,917
Per head:						
With labor	231	223	223	218	222	217
Without labor	229	220	220	215	219	214

[1] 5% on average investment including land.

[2] 5% for one year on silage, limestone, and urea for 100 days; 5% for ½ year on all other items making up operating costs.

[3] Adapted from Johnson, R. G. and Nodland, T. R., **Labor Used In Cattle Feeding,** Bulletin 451, Minnesota Agricultural Experiment Station, St. Paul, Minnesota, March, 1960; Williams, Willard F., and McDowell, James I., **Costs and Efficiency in Commercial Dry-Lot Cattle Feeding,** processed series P-509, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma, June, 1965.

Table 14. Costs of feeding 715 lb. yearlings to 1040 lb. slaughter cattle, 162 days on a high-energy corn silage ration, by size of enterprise and number of batches fed per year, Mississippi, 1964.

Item	No. fed per batch					
	100		300		500	
	(1 batch)	(2 batches)	(1 batch)	(2 batches)	(1 batch)	(2 batches)
Investment Costs:			dollars			
Depreciation:						
Lot, shelter & buildings	301	301	845	845	1,399	1,399
Feed storage	292	584	789	1,578	1,140	2,280
Feed handling equipment	93	129	194	309	385	577
Water system	138	138	170	170	234	234
Manure handling equip.	58	70	76	140	117	175
Miscellaneous equipment	50	50	50	50	50	50
Interest [1]	496	678	1,108	1,670	1,806	2,518
Total	1,428	1,950	3,232	4,762	5,131	7,233
Operating Costs:						
Cattle	14,171	28,342	42,513	85,026	70,855	141,710
Feed	3,601	7,202	10,803	21,606	18,005	36,010
Vet. and medicine	125	250	375	750	625	1,250
Repairs	744	1,056	1,847	2,710	2,878	4,127
Electricity	10	20	23	46	52	104
Interest on operating capital [2]	500	988	1,486	2,947	2,474	4,905
Total	19,151	37,858	57,047	113,085	94,889	188,106
Total specified costs	20,579	39,808	60,279	117,847	100,020	195,339
Labor [3]	232	464	656	1,312	1,088	2,176
Total costs	20,811	40,272	60,935	119,159	101,108	197,515
Per head:						
With labor	208	201	203	199	202	198
Without labor	206	199	201	196	200	195

[1] 5% on average investment including land.

[2] 5% for one year on feed; 5% for ½ year on all other items making up operating costs.

[3] Adapted from Johnson, R. G. and Nodland, T. R., **Labor Used In Cattle Feeding,** Bulletin 451, Minnesota Agricultural Experiment Station, St. Paul, Minnesota, March, 1960; Williams, Willard F., and McDowell, James I., **Costs and Efficiency in Commercial Dry-Lot Cattle Feeding,** processed series P-509, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma, June, 1965.

Table 15. Costs of feeding 715 lb. yearlings to 1040 lb. slaughter cattle, 141 days on a corn ration, by size of enterprise and number of batches fed per year, Mississippi, 1964.

Item	No. fed per batch					
	100		300		500	
	(1 batch)	(2 batches)	(1 batch)	(2 batches)	(1 batch)	(2 batches)
	dollars					
Investment Costs:						
Depreciation						
Lot, shelter & buildings	301	301	845	845	1,399	1,399
Feed storage	69	69	78	78	78	78
Feed handling and processing equipment	236	325	354	573	592	888
Water system	138	138	170	170	234	234
Manure handling equip.	58	70	76	140	117	175
Miscellaneous equip.	50	50	50	50	50	50
Interest [1]	394	394	769	769	1,181	1,181
Total	1,246	1,347	2,342	2,625	3,651	4,005
Operating Costs:						
Cattle	14,171	28,342	42,513	85,026	70,855	141,710
Feed	6,708	13,416	20,124	40,248	33,540	67,080
Vet. and medicine	125	250	375	750	625	1,250
Repairs	562	602	1,180	1,294	1,881	2,025
Electricity	9	18	27	54	45	90
Interest on operating capital [2]	540	1,065	1,600	3,174	2,663	5,286
Total	22,115	43,693	65,819	130,546	109,609	217,441
Total specified costs	23,361	45,040	68,161	133,171	113,260	221,446
Labor [3]	282	564	846	1,692	1,410	2,820
Total costs	23,643	45,604	69,007	134,863	114,670	224,266
Per head:						
With labor	236	228	230	225	229	224
Without labor	234	225	227	222	227	221

[1] 5% on average investment including land.

[2] 5% for ½ year on all items making up operating costs.

[3] Adapted from Johnson, R. G. and Nodland, T. R., **Labor Used In Cattle Feeding,** Bulletin 451, Minnesota Agricultural Experiment Station, St. Paul, Minnesota, March, 1960; Williams, Willard F., and McDowell, James I., **Costs and Efficiency in Commercial Dry-Lot Cattle Feeding,** processed series P-509, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma, June, 1965.

RETURNS

A considerable degree of seasonality is associated with cattle prices. Returns, then, depend rather heavily upon the time of year feeding is begun and when cattle are sold. To show the effect of seasonality, returns at the 5-year average level of prices are compared with those computed for a period when price relationships of animals to be put on feed and animals coming out of feedlots are normally the most favorable.

In computing these returns it is assumed that, on the average, one-half of each lot of calves conditioned would grade Good, the other half Standard, and that finished steers would be equally divided between Good and Choice grades. A death loss of 1 percent is also assumed. Since revenues are to be calculated on a per-head basis, death loss will, for simplicity, be accounted for by deducting 1 percent from the market value of the average animal conditioned or finished. Marketing charges of $3.75 per head are also deducted from the market value of animals sold. Neither labor nor transportation cost is deducted from returns computed below.

From Conditioning

Prices for 715-pound feeder steers averaged $19.82 per hundredweight during 1960-64 (Appendix Table 10). At that price, revenue from conditioned calves would have averaged $137 per head ($19.82 x 7.15 less 1 percent and less $3.75). Thus, at 1960-64 average cost-price relationships, conditioning calves would not, on the average, be profitable. Even without a charge for labor, losses could run as high as $23 per head, Table 16. Were all the labor hired, losses would be as much as $2.75 per head greater.

Were all, instead of only half, of the animals to grade Good, receipts would be $1.26 per hundredweight, or $9 per head, greater. Such receipts would give a small positive return to management and labor in the high-energy silage operations. But from that return transportation costs incurred would have to be deducted.

Timing operations to catch the more favorable seasonal prices would change the picture somewhat. In Mississippi, most feeding is begun in the fall, especially if silage is to be fed. Over the 1960-64 period calf prices were lowest in November, and heavy feeder prices were highest in April (Appendix Tables 9-10). But October calf prices averaged only 17 cents higher than those of November. Thus starting calves on feed in October and marketing them in April would make the enterprise somewhat more attractive, at least for the high-energy silage feeder, Table 17. Feeding a second batch following the group sold in the Spring would be highly unprofitable, because calves would be bought at peak prices and sold at the seasonal low.

Feeders who can add approximately 300 pounds on calves by grazing may find this a more profitable way to condition them. However, it should be remembered that the same resources required to condition the animal this way might be more profitably applied to producing another calf.

From Finishing

Based upon the 5-year average of prices of feeder steers and slaughter cattle, finishing appears considerably more attractive than does conditioning. Positive returns (exclusive of costs for labor and transportation) range from $6 per head on a single batch of 100 head fed the corn ration to $45 per head in the largest high-energy silage model (Table 18). Were all finished animals to grade Choice, receipts would run about $8.50 per head higher. Also, feeder-produced corn could alter these returns considerably.

The average feeding period for the three systems is approximately five months. Feeder steer prices for the 1960-64 period were lowest in December but monthly averages varied only $.09 per hundredweight during October-December (Appendix Table 10). Peak slaughter prices occurred in September;

Table 16. Net returns to labor and management per-head from conditioning 400-pound steer calves to 715-pound good and standard feeders, 1960-64 average steer calf and feeder prices.

Item	Number fed per batch					
	100		300		500	
	1 batch	2 batches	1 batch	2 batches	1 batch	2 batches
	(dollars per head)					
Net receipts [1]	137	137	137	137	137	137
Silage-Corn						
Costs	160	152	152	147	151	146
Loss	—23	—15	—15	—10	—14	—11
High-energy						
Costs	145	138	140	135	140	135
Loss	—8	—1	—3	2	—3	2

[1] At 19.82 percent less 1% death loss and $3.75 marketing charge.

Table 17. Net returns to labor and management per-head from conditioning 400-pound steer calves to 715-pound good and standard feeders, 1960-64 average October prices for steer calves and April prices for feeders.

Item	Number fed in single batch		
	100	300	500
	(dollars per head)		
Net receipts [1]	145	145	145
Silage-corn			
Costs	155	147	146
Net returns	—10	—2	—1
High-energy			
Costs	140	135	134
Net returns	5	10	11

[1] At $21.06 per hundredweight less 1% and less $3.75 marketing charges.

however, the range from September to December was only $.34 per hundredweight (Appendix Table 11). April slaughter prices were only $.74 per hundredweight below the peak prices of September.

Thus, on the average, it appears that placing steers on feed in November to hit the April slaughter market would be the best timing of a finishing enterprise. Returns would average about $6 per head higher than those based on the 5-year average of prices, Table 19.

Beginning a second batch in April to catch the peak prices of September would have the net effect of lowering returns $9 per head below those presented in Table 19—the price of the slaughter animal would rise $7 per head but April feeder prices are $16 per head higher than November ones. However, by waiting until May to begin the second batch, return for the group feed through the summer would decline only $6 below returns for the winter feeding—costs of the feeder cattle would be $12 higher but net receipts would increase $6.

A continuation of the conditioning cattle for finishing would not appear to be as attractive as finishing a second batch. The calf-feeder-slaughter animal price relationship would seem to favor selling calves and purchasing heavier animals for finishing.

Table 18. Net returns to labor and management per-head from finishing 715-pound feeder steers to 1040-pound choice and good slaughter steers, 1960-64 average feeder and slaughter prices.

Item	Number fed per batch					
	100		300		500	
	1 batch	2 batches	1 batch	2 batches	1 batch	2 batches
	(dollars per head)					
Net receipts[1]	240	240	240	240	240	240
Silage-corn						
Costs	229	220	220	215	219	214
Net returns	11	20	20	25	21	26
High-energy						
Costs	206	199	201	196	200	195
Net returns	34	41	39	44	40	45
Corn						
Costs	234	225	227	222	227	221
Net returns	6	15	13	18	13	19

[1] At $23.72 per hundredweight less 1% and less $3.75 marketing charges.

Table 19. Net returns to labor and management per-head from finishing 715-pound feeder steers to 1040-pound choice and good slaughter steers, 1960-64 average November feeder steer and April slaughter steer prices.

Item	Number fed in single batch		
	100	300	500
	(dollars per head)		
Net receipts[1]	239	239	239
Silage-corn			
Costs	222	213	212
Net returns	17	26	27
High-energy			
Costs	199	194	193
Net returns	40	45	46
Corn			
Costs	227	220	219
Net returns	12	19	20

[1] At $23.62 per hundredweight less 1% and less $3.75 marketing charges.

APPENDIX

Appendix Table 1. Feeding facilities and equipment for feeding 400 lb. calves to 715 lb. yearlings, 180 days on a silage-corn ration, by size of enterprise, Mississippi, 1964.

Item	Unit	Number fed		
		100	300	500
Land				
Feedlot and accompanying facilities	acre	1	1	2
Buildings and lots				
Cattle shed	sq. ft.	2,800	8,400	14,000
Feed room	sq. ft.	192	192	192
Concrete lot	sq. ft.	7,000	21,000	35,000
Lot fence	ft.	262	332	574
Concrete feed bunk, 5 ft. wide with 10 ft. roof	ft.	50	150	250
Feed storage facilities				
6.5 ton metal tank	no.	1	1	1
1,000 bu. metal bin	no.	1	1	1
20′ x 40′ silo[1]	no.	1		
26′ x 60′ silo[1]	no.		1	
36′ x 68′ silo[1]	no.			1
Feed handling and processing equipment				
Hammer mill and feed mixer	no.	1	1	1
Feed meter	no.	4	4	4
3″ grain auger 20′ long	no.	1	1	2
5″ grain auger 21′ long	no.	1	1	1
8″ portable auger 30′ long	no.	1	1	1
9″ auger mechanical feeder	ft.	62	162	344
Silage blower	no.	1	1	1
Water system				
Deep well, pump and 120-gallon tank	no.	1	1	1
3/4″ pipe	ft.	125	276	600
Automatic waterers	no.	2	4	8
Manure handling equipment				
Front-end loader	no.	1	1	1
Manure spreader	no.	1	1	1
Miscellaneous equipment				
Scales and shelter	no.	1	1	1
Headgate and chute	no.	1	1	1

[1] Silo capacity must be doubled if 2 batches are fed per year.

Appendix Table 2. Feeding facilities and equipment for feeding 400 lb. calves to 715 lb. yearlings, 180 days on a high-energy corn silage ration, by size of enterprise, Mississippi, 1964.

Item	Unit	Number fed		
		100	300	500
Land				
Feedlot and accompanying facilities	acre	1	1	2
Buildings and lots				
Cattle shed	sq. ft.	2,800	8,400	14,000
Feed room	sq. ft.	192	192	192
Concrete lot	sq. ft.	7,000	21,000	35,000
Lot fence	ft.	262	332	574
Concrete feed bunk, 5 ft. wide with 10 ft. roof	ft.	50	150	250
Feed storage facilities				
22′ x 50′ silo[1]	no.	1		
36′ x 68′ silo[1]	no.		1	
30′ x 60′ silo[1]	no.			2
Feed handling equipment				
9″ auger mechanical feeder	ft.	62	162	344
Silage blower	no.	1	1	1
Water system				
Deep well, pump and 120-gal. tank	no.	1	1	1
3/4″ pipe	ft.	125	276	600
Automatic waterers	no.	2	4	8
Manure handling equipment				
Front-end loader	no.	1	1	1
Manure spreader	no.	1	1	1
Miscellaneous equipment				
Scales and shelter	no.	1	1	1
Headgate and chute	no.	1	1	1

[1] Silo capacity must be doubled if 2 batches are fed per year.

Appendix Table 3. Feeding facilities and equipment for feeding 715 lb. yearlings to 1040 lb. slaughter cattle, 100 days on a silage-corn ration followed by 60 days on a corn ration, by size of enterprise, Mississippi, 1964.

Item	Unit	Number fed		
		100	300	500
Land				
Feedlot and accompanying facilities	acre	1	1	2
Buildings and lots				
Cattle shed	sq. ft.	2,800	8,400	14,000
Feed room	sq. ft.	192	192	192
Concrete lot	sq. ft.	7,000	21,000	35,000
Lot fence	ft.	262	332	574
Concrete feed bunk, 5 ft. wide with 10 ft. roof	ft.	50	150	250
Feed storage facilities				
6.5 ton metal tank	no.	1	1	1
1,000 bu. metal bin	no.	2	1	1
1,560 bu. metal bin	no.		1	1
18′ x 40′ silo[1]	no.	1		
26′ x 50′ silo[1]	no.		1	
28′ x 70′ silo[1]	no.			1
Feed handling and processing equipment				
Hammer mill and feed mixer	no.	1	1	1
Feed meter	no.	4	4	4
3″ grain auger 20′ long	no.	1	1	2
5″ grain auger 21′ long	no.	1	1	1
8″ portable auger 30′ long	no.	1	1	1
9″ auger mechanical feeder	ft.	62	162	344
Silager blower	no.	1	1	1
Water system				
Deep well, pump and 120-gal. tank	no.	1	1	1
3/4″ pipe	ft.	125	276	600
Automatic waterers	no.	2	4	8
Manure handling equipment				
Front-end loader	no.	1	1	1
Manure spreader	no.	1	1	1
Miscellaneous equipment				
Scales and shelter	no.	1	1	1
Headgate and chute	no.	1	1	1

[1] Silo capacity must be doubled if 2 batches are fed per year.

Appendix Table 4. Feeding facilities and equipment for feeding 715 lb. yearlings to 1040 lb. slaughter cattle, 162 days on a high-energy corn-silage ration, by size of enterprise, Mississippi, 1964.

Item	Unit	Number fed		
		100	300	500
Land				
Feedlot and accompanying facilities	acre	1	1	2
Buildings and lots				
Cattle shed	sq. ft.	2,800	8,400	14,000
Feed room	sq. ft.	192	192	192
Concrete lot	sq. ft.	7,000	21,000	35,000
Lot fence	ft.	262	332	574
Concrete feed bunk, 5 ft. wide with 10 ft. roof	ft.	50	150	250
Feed storage facilities				
26′ x 40′ silo[1]	no.	1		
36′ x 68′ silo[1]	no.		1	
16′ x 40′ silo[1]	no.		1	
36′ x 68′ silo[1]	no.			1
30′ x 60′ silo[1]	no.			1
Feed handling equipment				
9″ auger mechanical feeder	ft.	62	162	344
Silage blower	no.	1	1	1
Water system				
Deep well, pump and 120-gal. tank	no.	1	1	1
3/4″ pipe	ft.	125	276	600
Automatic waterers	no.	2	4	8
Manure handling equipment				
Front-end loader	no.	1	1	1
Manure spreader	no.	1	1	1
Miscellaneous equipment				
Scales and shelter	no.	1	1	1
Headgate and chute	no.	1	1	1

[1] Silo capacity must be doubled if 2 batches are fed per year.

Appendix Table 5. Feeding facilities and equipment for feeding 715 lb. yearlings to 1040 lb. slaughter cattle, 141 days on a corn ration, by size of enterprise, Mississippi, 1964.

Item	Unit	Number fed		
		100	300	500
Land				
Feedlot and accompanying facilities	acre	1	1	2
Buildings and lots				
Cattle shed	sq. ft.	2,800	8,400	14,000
Feed room	sq. ft.	192	192	192
Concrete lot	sq. ft.	7,000	21,000	35,000
Lot fence	ft.	262	332	574
Concrete feed bunk, 5 ft. wide with 10 ft. roof	ft.	50	150	250
Feed storage facilities				
6.5 ton metal tank	no.	2	1	1
1,000 bu metal bin	no.	1	2	2
1,560 bu. metal bin	no.	1	1	1
Feed handling and processing equipment				
Hammer mill and feed mixer	no.	1	1	1
Feed meter	no.	4	4	4
3″ grain auger 20′ long	no.	1	1	2
5″ grain auger 21′ long	no.	1	1	1
8″ portable auger 30′ long	no.	1	1	1
9″ auger mechanical feeder	ft.	62	162	344
Water system				
Deep well, pump and 120-gal. tank	no.	1	1	1
3/4″ pipe	ft.	125	276	600
Automatic waterers	no.	2	4	8
Manure handling equipment				
Front-end loader	no.	1	1	1
Manure spreader	no.	1	1	1
Miscellaneous equipment				
Scales and shelter	no.	1	1	1
Headgate and chute	no.	1	1	1

Appendix Table 6. Prices of input items, Mississippi.[1]

Item	Unit	Cost per unit
Feed ingredients		
Yellow corn (No. 2 grade)	bu.	$ 1.33
Cottonseed meal (41% protein)	ton	70.00
Cottonseed hulls	ton	20.00
Deflourinated rock phosphate	cwt.	62.00
Mineralized salt	cwt.	2.75
Vitamin A premix	lb.	1.50
Corn silage[2]		
Conventional	ton	5.41
High-energy	ton	6.76
Urea	ton	100.00
Pure antibiotic	lb.	23.00
Ground limestone	cwt.	1.00
Stilbestrol	implant	.125
Land	acre	100.00
Lot		
Concrete in lot	sq. ft.	.30
Lot fence	ft.	1.50
Concrete feed bunk, 5 ft. wide for mechanical feeder	ft.	5.50
Roof for feed bunk, 10 ft. wide	ft.	3.50
Buildings		
Cattle shed	sq. ft.	1.50
Feed room	sq. ft.	2.00
Feed storage facilities		
6.5 ton metal tank	each	226.00
1,000 bushel metal bin	each	394.00
1,560 bushel metal bin	each	536.00
16′ x 40′ silo	each	4,220.00
18′ x 40′ silo	each	4,850.00
20′ x 40′ silo	each	5,450.00
22′ x 50′ silo	each	6,600.00
26′ x 40′ silo	each	7,300.00
26′ x 50′ silo	each	9,500.00
26′ x 60′ silo	each	11,000.00
28′ x 70′ silo	each	13,500.00
30′ x 60′ silo	each	13,000.00
36′ x 68′ silo	each	15,500.00
Feed conveying and distributing equipment		
3″ grain auger, 20 ft. long	each	81.20
5″ grain auger, 21 ft. long	each	172.52
8″ portable auger, 30 ft. long	each	600.00
9″ auger feeder	ft.	9.00
Silage blower	each	900.00
Feed processing equipment		
10″ hammer mill	each	1,096.69
Feed mixer	each	593.55
Feed meter	each	50.00
Waterers, automatic	each	150.00
Deep-well water system		
Drilling and 4″ casing	ft.	1.99
3/4″ pipe	ft.	.21
1 H. P. pump equipped with 120-gallon tank	each	465.23
Scales and shelter	each	600.00
Loading chute and headgate	each	200.00
Front-end loader	each	468.00
Manure spreader	each	700.00
Labor	hr.	1.25

[1] Corn and cottonseed meal prices are simple monthly averages of Market News Service prices at Jackson, 1960-64. Other feed ingredients prices obtained from feed mill operators represent prices during the same period. Other prices obtained from farm catalogs, equipment dealers, and other studies are representative of 1964.

[2] See Appendix Table 7 for costs.

Appendix Table 7. Corn for silage: Estimate of production and harvesting costs per acre, Mississippi, 1964.[1]

Item	Unit	Quantity	Price	Amount
			(dol.)	(dol.)
Seed	bu.	0.3	12.00	3.60
Fertilizer				
20% Superphosphate	cwt.	2.5	1.75	4.38
60% Muriate of Potash	cwt.	1.5	2.75	4.12
Ammonium Nitrate	cwt.	4.0	3.80	15.20
Lime (custom spread)[2]	ton	0.2	8.00	1.60
Herbicide	lb.	1.2	2.90	3.48
Tractor operation	acre	1.0	14.95	14.95
Equipment operation	acre	1.0	10.49	10.49
Labor	hr.	8.35	1.00	8.35
Interest on land[3]				15.00
Total cost per acre				81.17
Total cost per ton				
Conventional				5.41
High-energy				6.76

Source: Adapted from McReynolds, John T. and Hamill, James G., **Budgets for Forage Crops in the Brown Loam Area of Mississippi**, Mississippi Agricultural Experiment Station AEc. M. R. No. 46, August, 1965.

[1] This budget is based upon using good, deep, well-drained soils with an expected yield of 15 tons per acre of conventional silage. This same land and cultural practices were expected to yield the equivalent of at least 80 bushels of corn or 12 tons of high-energy silage. The latter is reduced 20 percent to allow for less stalk and a lower moisture content.

[2] One ton pro-rated over 5 years.

[3] Interest charged at 5 percent on land valued at $300 per acre.

Appendix Table 8. Years of expected life and depreciation rates of facilities.[1]

Item	Years of expected life	Annual depreciation rate
	number	percent
Lot and buildings	25	4
Silos	25	4
Metal bins	20	5
Augers	10	10
Feed processing equipment and waterers	10	10
Deep well, pump and tank	10	10
Water pipe	15	6.67
Scales and shelter	20	5
Headgate and chute	10	10
Front-end loader	10	10
Manure spreader	10	10
Silage blower	12	8.33

[1] Where the same item of feed processing and handling equipment and manure handling equipment was used for all sizes of enterprises, the depreciation rates were based upon the amount of use.

Appendix Table 9. Steer calf prices: Monthly prices for 400 lb. calves, Memphis, 1960-64.[1]

Month	1964	1963	1962	1961	1960	5-year average
	(dollars per hundredweight)					
January	21.61	23.96	22.65	20.66	22.10	22.20
February	21.93	23.90	23.71	21.28	23.08	22.78
March	22.71	24.30	24.54	23.12	24.08	23.75
April	20.66	25.13	25.22	22.88	23.96	23.57
May	18.89	23.87	23.61	22.67	24.56	22.72
June	17.95	23.36	23.37	20.64	22.52	21.57
July	16.83	23.78	23.22	19.90	21.52	21.05
August	16.56	23.34	23.19	21.64	19.71	20.89
September	17.00	22.52	23.77	21.10	19.64	20.81
October	16.79	21.41	24.02	20.18	19.25	20.33
November	16.79	20.63	23.64	21.60	18.16	20.16
December	15.71	20.16	24.56	21.72	19.58	20.35
Annual Average	18.62	23.03	23.79	21.45	21.51	21.68

Source: **Market News Service**, Memphis.

[1] Prices for 1962-64 are an average for choice, good, and standard grades. Quoted prices for 1960 and 1961 were for choice and good combined and for common and medium combined; therefore, the above 1960 and 1961 prices are an average of these two sets of prices. These prices were used because they are near the level of prices received for calves in Mississippi.

Appendix Table 10. Feeder steer prices: Monthly prices for 715 lb. good and standard grades of steers, Memphis, 1960-64.[1]

Month	1964	1963	1962	1961	1960	5-year average
			(dollars per hundredweight)			
January	18.41	21.92	19.74	20.03	20.85	20.19
February	18.82	20.85	20.24	19.64	22.10	20.33
March	19.10	21.18	20.88	20.92	23.05	21.03
April	18.06	21.76	21.58	20.65	23.25	21.06
May	16.56	20.96	21.02	20.94	23.28	20.55
June	16.24	20.63	20.50	19.58	22.20	19.83
July	15.70	21.34	20.74	19.52	21.14	19.69
August	15.84	20.13	20.88	20.72	18.71	19.26
September	15.94	20.19	21.36	20.04	18.55	19.22
October	15.68	19.28	21.98	19.74	17.75	18.89
November	15.44	18.50	22.00	20.34	17.89	18.83
December	14.82	17.50	22.38	20.70	18.92	18.80
Annual average	16.72	20.42	21.10	20.22	20.64	19.82

Source: **Market News Service,** Memphis.

[1] These prices were used because they are near the level of prices received for steers and heifers in Mississippi. Marketing charges were estimated to average $.53 per hundredweight.

Appendix Table 11. Slaughter steer prices: Monthly prices for 1040 lb. choice and good grade steers, Memphis, 1960-64.[1]

Month	1964	1963	1962	1961	1960	5-year average
			(dollars per hundredweight)			
January	21.78	25.66	24.54	25.07	24.04	22.02
February	21.23	23.82	24.08	24.41	24.71	23.60
March	21.14	22.44	24.83	23.71	25.53	23.53
April	20.59	22.74	25.14	23.58	26.06	23.62
May	19.68	22.12	24.68	22.58	25.65	22.94
June	19.86	22.18	24.46	21.88	24.95	22.67
July	21.52	23.82	24.48	22.09	24.79	23.34
August	23.08	23.83	25.18	23.32	24.07	23.90
September	23.68	23.62	27.39	23.42	23.70	24.36
October	23.26	23.47	26.90	23.44	24.16	24.25
November	22.69	23.09	27.03	24.03	23.90	24.15
December	22.12	21.70	26.70	25.01	24.58	24.02
Annual average	21.72	23.21	25.45	23.54	24.68	23.72

Source: **Market News Service,** Memphis.

[1] Marketing charges were estimated to average $.36 per hundredweight.

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Cultural Practices and Costs and Returns for a Tung Enterprise

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AGRICULTURAL EXPERIMENT STATION
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SUMMARY AND CONCLUSION

Tung merits consideration from those who are willing to plan over extended periods of time and are located in areas that meet the climatic and soil requirements for successful tung production. Temperature is the most critical requirement for profitable tung production and cultivation is the most important annual operation. If trees are kept cleanly cultivated the danger of leaf spot will be reduced, temperatures will tend to be more stable, fertilizer will be more beneficial, and harvesting cost will be reduced.

Since the expenses and revenues from a tung orchard change from year to year, it is necessary to consider interest rates when calculating the net income that can be expected from tung. The results of this study indicate that for the five price levels and three interest rates considered from seven to fourteen years are required to recover expenses plus interest, excluding cost for land, from a tung enterprise. Optimum replacement cycles for the five prices considered and for six, seven and eight percent interest rates ranged from 26 to 28 years. Although strictly speaking from 26 to 28 years would be the most profitable replacement cycle, results indicate that there is little difference in equivalent annual net income for replacement cycles of from 20 to 30 years.

At an interest rate of seven percent and a price of 26 cents per pound of oil, the equivalent annual net income from tung for the optimum replacement period is $26.55 per acre. Thus, for this interest rate - price combination, returns from a tung enterprise for the optimum production period are equivalent to an annual net income of $26.55 per acre from an enterprise with an annual production period.

Cultural Practices and Costs and Returns for a Tung Enterprise

By CHARLES E. POWE, W. W. KILBY, and A. D. SEALE, JR.

CULTURAL PRACTICES

The commercial tung industry in Mississippi began in the middle 1930's. Thousands of acres of virgin pine timber had been "clean cut," leaving vast areas of land unproductive. Several cash crops were tried but were unsuccessful in establishing an income from the soil. The first tung plantings flourished and the industry grew to nearly 100,000 acres of orchards in South Mississippi.

The productive life of a tung tree is about 30 years. Many acres of the original plantings are approaching this age. Current and prospective growers need guides as to cost of establishing an orchard and its annual costs and returns. The purpose of this study is to outline recommended cultural practices and to estimate costs and returns over the life span of a tung orchard when these practices are followed.

Climatic Requirements

The most important requirement for tung production is the temperature range in an area. A long growing season with at least 45 inches of rainfall rather evenly distributed through the year is required, along with moderate to cold winter temperatures. Dormant tung trees will withstand temperatures as low as 5°-8°F. However, 28°-30° temperatures will kill the buds in the early Fall or in bloom stage in the Spring. Tung requires about 350 to 400 hours of chilling at temperatures of 45°F or lower to cause uniform bloom and growth in the Spring. Thus, the commercial tung belt in the United states has been established south of 31°-30′ North Latitude and north of 29°-30′ North Latitude from east Florida to east Texas.

Soil Requirements

Soil type and terrain are the next most important requirements in tung production. Good drainage of water and air is essential. Soils should be deep, well-drained, sandy clay with uniform color for good tung production. Soils having a subsoil that is white or light gray, or yellow areas will be poorly drained and are undesirable. Some of the least desirable soil types are Susquehanna, Caddo, and Leon. Some examples of the better types for tung are: Ruston, Orangeburg, Red Bay, and Norfolk sandy loams.

Good air drainage helps reduce damage caused by late Spring frosts. Hill tops and slopes are good planting areas because colder air will drain into lower land on a still night. Where the slope is 4 degrees or over, trees should be planted on a contour plan.

Cultivation

Proper cultivation is the most important annual operation. Newly planted and young trees must be clean-cultivated throughout the growing season if satisfactory growth and development are to be obtained. A mulch of sawdust, hay, tung hulls, or paper may be used the first two years to control grass and weeds around newly planted trees.

Exacting cultural experiments have demonstrated that competing grass and weeds in a mature orchard are detrimental to tree growth and production.[1] Cultivation has many beneficial effects on a tung orchard. A thorough disking in the late winter will destroy and incorporate all vegetation, old tung leaves and other debris into the soil. A clean, firm orchard floor will absorb more heat from the sun and thus have more heat stored to radiate back to the air on a cold Spring night. It has been estimated that the air temperature over a clean firm soil may remain 1 to 3 degrees warmer than where a cover crop or trashy condition is present. Furthermore, when the old tung leaves are destroyed early in the Spring, the primary source of infection of tung leaf spot **(Mycosphaerella alueritidis)** is greatly reduced. A clean orchard provides ideal conditions for the Spring application of fertilizer.

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[1] Kilby, W. W., C. B. Shear and T. Van der Zwet, **Cultivation of Tung,** Mississippi Agricultural Experiment Station, Bul. No. 696, State College, Mississippi, November, 1964.

After fertilizer has been applied, the orchard will require 2 or 3 shallow cultivations during the growing season to control annual vegetation. Briars, grass and volunteer tung seedlings may be eliminated from the immediate tree rows by spraying with the herbicide 2,4,5-T.[2]

During final cultivation special attention should be applied to leveling the land and smoothing the surface. This is necessary for mechanical harvesting and will greatly reduce the cost and waste even for hand harvesting. Timely and effective use of the proper cultivation equipment will pay greater returns on money spent than will any other single orchard practice.

Fertilization

Most soils in the tung belt are inherently low in fertility, and good culture must be supplemented with proper fertilization. Three major elements, nitrogen, phosphorus, and potassium must be applied.

Newly planted and young trees should be fertilized with a mixed material of a 1-2-1 ratio of nitrogen, phosphorus, and potassium, respectively.

In mature, bearing orchards the amounts of fertilizer recommended will vary with the crop set on the trees in the Spring. See Table 1 for these amounts. Where a mixed fertilizer is preferred a 2-1-2 ratio of nitrogen, phosphorus, and potassium is recommended. Where special equipment is available for the application of more concentrated material the following sources are recommended; for nitrogen — anhydrous ammonia, aqua ammonia, ammonium nitrate and urea; for phosphorus—superphosphate; and for potassium — muriate of potash. Phosphorus and potassium may be purchased in a commercial mix of 0-10-30 or 0-20-20. Split applications of fertilizer in tung have not proven to be advantageous. The complete application should be made as early in the Spring as possible.

Where land that has been continuously cultivated is planted to tung, it has been found that zinc may be deficient. If it is found that zinc is needed, 2 ounces of zinc sulphate per tree should be applied.

Harvest

Tung nuts mature in the Fall and drop to the ground during the period from late September to late October. Harvesting should not begin until the sap has dried out, usually the second week of November. However, an effort should be made to complete harvest before the leaves drop as a more complete job can be done at less cost per ton. Leaves normally drop soon after the first killing frost.

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[2] Sitton, B. G. and Lewis, W. A., Chemical Control of Briars, Volunteer Seedings and other Broad-leaf Weeds in Tung Orchards, Memo Information Sheet, USDA, Tung Laboratory, Bogalusa, Louisiana, 1961.

The nuts should be delivered to the mill as dry as possible. Custom mills charge on gross weight delivered to the mill site. Thus, fruit carrying excess moisture increasing milling cost per pound of oil recovered.

Nuts may be dried naturally by hanging them in crocus (burlap) sacks in the trees, by placing them in narrow well-ventilated bins or simply leaving them on the ground until dry times occur. Tung nuts do not deteriorate on the ground until they begin to germinate in the Spring.

COSTS AND RETURNS

Relative to row crops, tung is a long term investment and costs will exceed returns for the first few years of an orchard's life. The question arises as to how long will be required to break-even on a tung orchard. When one considers the interest that an alternative investment could be earning, the question becomes: How long is required to recover expenses and interest from a tung enterprise? The answer will depend upon the return over expenditures that is obtained from the orchard and the interest rate considered. Costs must be adjusted upward or compounded by the rate of interest. Likewise, revenues which cannot be realized until several years into the future must be adjusted downward or discounted by the rate of interest.

Since returns will not be constant over the life of the orchard, it is difficult to determine the value of the enterprise relative to the value of alternative investments. Enterprises must be compared on an equivalent basis before the most profitable one can be selected Equivalent annual net incomes from a tung enterprise would provide a basis for comparisons with annual crops such as cotton, corn, or soybeans. In this study net returns are adjusted to annual income streams by compounding expenses and discounting revenues for the optimum life of the orchard. To further complicate the problem, the optimum life of the orchard is a function of both the interest rate considered and the price of tung oil. Thus, we must determine the optimum life or replacement period of the orchard before we can determine the maximum annual net income to be expected.

Expenditures

In order to estimate the costs that will be incurred in a tung enterprise, we must select a particular type of technology and particular prices for input items. The cultural practices suggested above are based on representative management of more efficient orchards. The costs for items of production, types of equipment and performance rates, cultural practices, labor and power requirements, and annual costs for individual operations are shown in Appendix Tables 1-7. Annual expenditures considered in this study do not include a cost for land.[3] Many producers recover part of this cost by limited grazing of the orchard.

The estimated cost of establishing and maintaining an acre of tung for one year was $30.22 (Table 2). Expenditures were made up of payments for trees, fertilizer, labor and equipment. Maintenance cost was $11.47 and $12.59 for the second and third years, respectively. After the third year the annual cost consisted of maintenance cost and the cost of harvesting and milling the nut crop. The high-

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[3] Net income as used in this report does not consider a cost for land.

Table 1. Fertilizer recommendations for tung orchards in South Mississippi.

	Plant nutrient		
Type of orchard	N	P_2O_5	K_2O
Non-bearing	(Pounds of element per tree)		
First year	.05	.10	.05
Second year	.10	.20	.10
Third year	.15	.30	.15
Bearing	(Pounds of element per acre)		
0-1 ton nuts per acre	75	25	75
1-2 tons nuts per acre	100	50	100
2 or more tons nuts per acre	130	60	160

Table 2. Summary of annual cost per acre for tung.

	Cost of					
Year	Trees	Fertilizer[1]	Labor and equipment	Harvesting[2]	Milling[3]	Total
1[4]	12.50	2.22	15.50	------	-	30.22
2	------	3.32	8.15	------	------	11.47
3	------	4.44	8.15	------	------	12.59
4	------	6.66	7.78	5.96	3.34	23.74
5	------	10.37	10.09	13.39	7.50	41.35
6	------	10.37	10.09	22.31	12.50	55.27
7	------	13.71	10.09	31.23	17.50	72.53
8	------	15.37	10.09	35.70	20.00	81.16
9	------	17.04	10.09	40.16	22.50	89.79
10	------	17.37	10.09	41.05	23.00	91.51
11	------	17.70	10.09	41.94	23.50	93.23
12	------	18.04	10.09	42.84	24.00	94.97
13	------	18.37	10.09	43.73	24.50	96.69
14	------	18.70	10.09	44.62	25.00	98.41
15	------	18.28	10.09	43.47	24.36	96.20
16	------	17.70	10.09	41.90	23.48	93.17
17	------	17.11	10.09	40.34	22.61	90.15
18	------	16.53	10.09	38.78	21.73	87.13
19	------	15.93	10.09	37.22	20.86	84.10
20	------	15.36	10.09	35.66	19.98	81.09
21	------	14.78	10.09	34.10	19.11	78.08
22	------	14.19	10.09	32.53	18.23	75.04
23	------	13.61	10.09	30.97	17.36	72.03
24	------	13.02	10.09	29.41	16.48	69.00
25	------	12.44	10.09	27.85	15.61	65.99
26	------	11.87	10.09	26.29	14.73	62.98
27	------	11.28	10.09	24.73	13.86	59.96
28	------	10.69	10.09	23.16	12.98	56.92
29	------	10.37	10.09	21.60	12.11	54.17
30	------	10.37	10.09	20.04	11.23	51.73
31	------	10.37	10.09	18.48	10.36	49.30

[1] Fertilizer costs for years 1-4 were based upon application of 10-20-10. Costs for years 5-30 were based upon 75 lbs. N, 25 lbs. P_2O_5 and 75 lbs. K_2O for yields of from 0-1 tons with an additional cost of $.0013872 for N, $.0015583 for P_2O_5 and $.0012222 for K_2O for each pound of nuts above one ton.

[2] Harvesting cost calculated at the rate of $20.00 per ton of nuts for 85 percent of crop and $35.40 per ton for 15 percent of crop.

[3] Milling cost calculated as $12.50 per ton of nuts.

[4] Cost of establishment plus cost for first year.

Table 3. Estimated tung nut and oil yields by age of trees.

Year	Production per acre		
	Nuts		Oil
	(pounds)	(pounds) (adjusted)[1]	(pounds)[2]
1	0	0	0
2	0	0	0
3	0	0	0
4	667	534	84.96
5	1,500	1,200	190.92
6	2,500	2,000	318.20
7	3,500	2,800	445.48
8	4,000	3,200	509.12
9	4,500	3,600	572.76
10	4,600	3,680	585.49
11	4,700	3,760	598.22
12	4,800	3,840	610.94
13	4,900	3,920	623.67
14	5,000	4,000	636.40
15	4,871	3,897	620.02
16	4,696	3,757	597.74
17	4,521	3,617	575.47
18	4,346	3,477	553.20
19	4,171	3,337	530.92
20	3,996	3,197	508.65
21	3,821	3,057	486.37
22	3,646	2,917	464.10
23	3,471	2,777	441.83
24	3,296	2,637	419.55
25	3,121	2,497	397.28
26	2,946	2,357	375.00
27	2,771	2,217	352.73
28	2,596	2,077	330.45
29	2,421	1,937	308.18
30	2,246	1,797	285.91
31	2,071	1,657	263.63
Total	99,674	79,743	12,687.19

[1] Adjusted for a loss of 20 percent annually because of spring and fall cold damage to the buds.

[2] Assuming the average oil content of whole fruit to be 18.5 percent and the average efficiency of the mill in oil recovery to be 86.0 percent.

est annual cost was $98.41 for the fourteenth year. After the fourteenth year annual cost declined.

Yield

The yield of a tung orchard is dependent upon several factors and fluctuates from one year to another. Annual yields were estimated from a typical orchard where good management and the cultural practices outlined in this study are followed (Table 3). Tung orchards normally cannot be expected to produce a nut crop until the fourth year. Yield in the fourth year will be relatively small, but will increase until the orchard reaches maturity at about fourteen years.

Yield in a particular year may be substantially reduced because of winter killing. Experience has shown that over the life of an orchard about twenty percent of the buds will be lost because of Spring and Fall cold damage. In order to reflect this damage, nut yields were adjusted downward by twenty percent. The adjusted yield (Table 3) was used as a basis for estimating the oil yield that can be expected. In converting nut yields to oil, an oil content of 18.5 percent for whole fruit and a mill recovery of 86 percent were used.

Gross Returns and Returns Over Expenditures

Gross returns depend upon yield of the orchard and the price received for tung oil. Using the yield data presented in Table 3, we may determine expected gross returns for any particular price of tung oil. The prices considered were 20, 22, 24, 26, and 28 cents per pound. Gross returns for these prices are presented in Table 4. Since there was no yield for the three years immediately after establishment, no return was anticipated. Returns began in the fourth year and increased until the fourteenth year for all price levels. After year fourteen, gross returns declined.

Annual returns above expenditures were computed by deducting annual cost from gross returns. These are summarized for each of the five price levels in Table 5.

At the 24 cent price, revenues will not equal annual expenses until the fifth year, and will not exceed them by as much as $30 per acre until the seventh year. At prices of 20 cents or lower, six or more years must elapse before an orchard begins to show a return over expense, even if interest on annual expense is not considered. From the data shown in Table 5 one can readily detect the year in which returns exceed expenses, but if interest on the net expenditures during the preceding years is considered, the break - even year is not immediately obvious.

Years Required to Break Even

The years required to recover expenses plus interest (excluding cost of land) from a tung enterprise for six, seven, and eight percent interest rates and 20, 22, 24, 26, and 28 cent prices of oil are presented in Table 6.

For the price - interest rate combinations considered, the shortest break-even period was seven years for the 28 cent per pound price of oil and six and seven percent interest rates. Fourteen years were required to recover expenses plus interest with the 20 cent price and eight percent interest rate. The number of years required to recover expenses plus interest for the other prices and interest rates ranged from eight to thirteen years.

Replacement Cycle

In order to determine the optimum replacement cycle for a tung orchard, the present value of the net returns must be maximized for each possible replacement cycle. The cycle with the highest present value is the most profitable replacement plan.

Optimum replacement cycles for the five prices considered and for six, seven and eight percent interest rates range from 26 to 28 years (Table 7). It should be pointed out that strictly speaking this would be the optimum length of time before re-establishment of the orchard; however, results indicate that there is little difference in annual net income for replacement cycles of from 20 to 30 years (Tables 9-11). At the seven percent interest rate and 26 cent price, the equivalent annual net income is $25.31 per acre for the 20-year cycle compared to $26.55 for the optimum 27-year cycle, Table 10. An extension of the replacement cycle to 30 years results in a decrease in the equivalent annual net income of only fifteen cents per acre.

Equivalent Annual Net Income

In order to compare an enterprise which is characterized by expenses and revenues incurred over several years

Table 4. Gross returns per acre from tung for specified prices by age of trees.

	Cents per pounds for tung oil				
Year	20	22	24	26	28
			(Dollars per acre)		
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	16.99	18.69	20.39	22.09	23.79
5	38.18	42.00	45.82	49.64	53.46
6	63.64	70.00	76.37	82.73	89.10
7	89.10	98.01	106.92	115.82	124.73
8	101.82	112.01	122.19	132.37	142.55
9	114.55	126.01	137.46	148.92	160.37
10	117.10	128.81	140.52	152.23	163.94
11	119.64	131.61	143.57	155.54	167.50
12	122.19	134.41	146.63	158.84	171.06
13	124.73	137.21	149.68	162.15	174.63
14	127.28	140.01	152.74	165.46	178.19
15	124.00	136.40	148.80	161.21	173.61
16	119.55	131.50	143.46	155.41	167.37
17	115.09	126.60	138.11	149.62	161.13
18	110.64	121.70	132.77	143.83	154.90
19	106.18	116.80	127.42	138.04	148.66
20	101.73	111.90	122.08	132.25	142.42
21	97.27	107.00	116.73	126.46	136.18
22	92.82	102.10	111.38	120.67	129.95
23	88.37	97.20	106.04	114.88	123.71
24	83.91	92.30	100.69	109.08	117.47
25	79.46	87.40	95.35	103.29	111.24
26	75.00	82.50	90.00	97.50	105.00
27	70.55	77.60	84.66	91.71	98.76
28	66.09	72.70	79.31	85.92	92.53
29	61.64	67.80	73.96	80.13	86.29
30	57.18	62.90	68.62	74.34	80.05
31	52.73	58.00	63.27	68.54	73.82

Source: Based on yield data shown in Table 3

with an enterprise where expenses and revenues are incurred in one growing season, an equivalent term of value is essential. If an alternative enterprise would produce an annual return over expenditure of $15.00 per acre, which would be the logical choice, tung or the alternative? At an interest rate of seven percent and a price of 26 cents per pound of oil, the equivalent annual net income from tung for optimum replacement period is $26.55 (Table 8). Thus, the net returns from a tung enterprise for the optimum production period are equivalent to an annual net income of $26.55 from an enterprise such as soybeans, cotton or corn. The returns for other interest rate-prices combinations shown in Table 8 may be used for similar comparisons. Equivalent annual net incomes for replacement periods other than the optimum are presented in Tables 9, 10, and 11.

Table 5. Annual return over annual expense per acre from tung for specified prices by age of trees.

Year	Cents per pounds for tung oil				
	20	22	24	26	28
			(Dollars per acre)		
1[1]	—30.22	—30.22	—30.22	—30.22	—30.22
2	—11.47	—11.47	—11.47	—11.47	—11.47
3	—12.59	—12.59	—12.59	—12.59	—12.59
4	—6.75	—5.05	—3.35	—1.65	0.05
5	—3.17	0.65	4.47	8.29	12.11
6	8.37	14.73	21.10	27.46	33.83
7	16.57	25.48	34.39	43.29	52.20
8	20.66	30.85	41.03	51.21	61.39
9	24.76	36.22	47.67	59.13	70.58
10	25.59	37.30	49.01	60.72	72.43
11	26.41	38.38	50.34	62.31	74.27
12	27.22	39.44	51.66	63.87	76.09
13	28.04	40.52	52.99	65.46	77.94
14	28.87	41.60	54.33	67.05	79.78
15	27.80	40.20	52.60	65.01	77.41
16	26.38	38.33	50.29	62.24	74.20
17	24.94	36.45	47.96	59.47	70.98
18	23.51	34.57	45.64	56.70	67.77
19	22.08	32.70	43.32	53.94	64.56
20	20.64	30.81	40.99	51.16	61.33
21	19.19	28.92	38.65	48.38	58.10
22	17.78	27.06	36.34	45.63	54.91
23	16.34	25.17	34.01	42.85	51.68
24	14.91	23.30	31.69	40.08	48.47
25	13.47	21.41	29.36	37.30	45.25
26	12.02	19.52	27.02	34.52	42.02
27	10.59	17.64	24.70	31.75	38.80
28	9.17	15.78	22.39	29.00	35.61
29	7.47	13.63	19.79	25.96	32.12
30	5.45	11.17	16.89	22.61	28.32
31	3.43	8.70	13.97	19.24	24.52

Source: Based on data shown in Tables 2 and 4

[1] Establishment cost plus cost for the first year.

Table 6. Years required to recover expenses plus interest from a tung enterprise for specified rates of interest and prices.

Rate of interest	Cents per pound for tung oil				
	20	22	24	26	28
			(years)		
6	12	10	8	8	7
7	13	10	9	8	7
8	14	10	9	8	8

Source: Computed from data shown in Tables 2 and 4.

Table 7. Optimum replacement cycle for a tung orchard for specified rates of interest and prices.

Rate of interest	Cents per pound for tung oil				
	20	22	24	26	28
			(years)		
6	27	27	26	26	26
7	28	27	27	27	27
8	28	28	28	27	27

Source: Computed from data shown in Table 5.

Table 8. Equivalent annual net incomes[1] from tung for specified rates of interest and prices.

Rate of interest	Cents per pound for tung oil				
	20	22	24	26	28
			(dollars per acre)		
6	6.39	13.78	21.18	28.58	35.97
7	5.02	12.20	19.37	26.55	33.72
8	3.68	10.63	17.58	24.53	31.49

Source: Computed from data shown in Tables 2 and 4.

[1] Equivalent annual net incomes were computed by compounding expenses and discounting revenues to adjust the net returns to annual income streams.

Table 9. Equivalent annual net income[1] from tung for specified prices and six percent interest rate.

Year	Cents per pounds for tung oil				
	20	22	24	26	28
			(dollars per acre)		
2	—22.39	—22.39	—22.39	—22.39	—22.39
3	—19.55	—19.55	—19.55	—19.55	—19.55
4	—16.95	—16.56	—16.17	—15.78	—15.39
5	—14.94	—13.95	—12.95	—11.95	—10.96
6	—12.08	—10.31	—8.54	—6.78	—5.01
7	—9.18	—6.56	—3.95	—1.33	1.29
8	—6.66	—3.28	0.10	3.49	6.87
9	—4.39	—0.31	3.78	7.86	11.94
10	—2.53	2.13	6.79	11.45	16.12
11	—0.98	4.18	9.33	14.48	19.63
12	0.36	5.93	11.50	17.07	22.64
13	1.52	7.45	13.39	19.32	25.26
14	2.54	8.80	15.05	21.31	27.57
15	3.38	9.90	16.42	22.94	29.46
16	4.05	10.79	17.52	24.25	30.99
17	4.60	11.50	18.41	25.31	32.21
18	5.04	12.08	19.12	26.16	33.20
19	5.40	12.54	19.69	26.83	33.97
20	5.68	12.91	20.13	27.36	34.59
21	5.90	13.19	20.48	27.77	35.06
22	6.07	13.41	20.74	28.08	35.41
23	6.20	13.57	20.93	28.30	35.66
24	6.29	13.68	21.06	28.45	35.84
25	6.35	13.74	21.14	28.54	35.93
26	6.38	13.78	21.18	28.58	35.97
27	6.39	13.78	21.18	28.57	35.96
28	6.38	13.76	21.14	28.53	35.91
29	6.35	13.72	21.08	28.45	35.81
30	6.30	13.64	20.99	28.33	35.68
31	6.23	13.55	20.87	28.19	35.51

Source: Computed from data shown in Tables 2 and 4.

[1] Equivalent annual net incomes were computed by compounding expenses and discounting revenues to adjust the net returns to annual income stream.

Table 10. Equivalent annual net income[1] from tung for specified prices and seven percent interest rate

	Cents per pounds for tung oil				
Year	20	22	24	26	28
			(dollars per acre)		
2	—22.64	—22.64	—22.64	—22.64	—22.64
3	—19.79	—19.79	—19.79	—19.79	—19.79
4	—17.23	—16.84	—16.46	—16.08	—15.70
5	—15.29	—14.31	—13.33	—12.35	—11.37
6	—12.52	—10.79	—9.05	—7.32	—5.59
7	—9.75	—7.18	—4.62	—2.06	0.50
8	—7.34	—4.03	—0.73	2.58	5.88
9	—5.18	—1.20	2.79	6.77	10.76
10	—3.42	1.13	5.67	10.22	14.76
11	—1.94	3.07	8.09	13.10	18.12
12	—0.68	4.73	10.15	15.57	20.99
13	0.41	6.18	11.94	17.71	23.48
14	1.36	7.44	13.52	19.59	25.67
15	2.15	8.48	14.80	21.13	27.46
16	2.78	9.31	15.84	22.37	28.90
17	3.30	9.99	16.68	23.37	30.06
18	3.71	10.53	17.35	24.17	30.99
19	4.05	10.97	17.89	24.81	31.73
20	4.31	11.31	18.31	25.31	32.31
21	4.52	11.58	18.64	25.71	32.77
22	4.69	11.79	18.90	26.01	33.11
23	4.81	11.95	19.09	26.23	33.37
24	4.90	12.06	19.22	26.38	33.54
25	4.96	12.14	19.31	26.48	33.65
26	5.00	12.18	19.36	26.53	33.71
27	5.02	12.20	19.37	26.55	33.72
28	5.02	12.19	19.36	26.53	33.70
29	5.01	12.16	19.32	26.48	33.64
30	4.97	12.11	19.26	26.40	33.54
31	4.92	12.05	19.17	26.30	33.42

Source: Computed from data shown in Tables 2 and 4.

[1] Eqivalent annual net incomes were computed by compounding expenses and discounting revenues to adjust the net returns to annual income streams.

Table 11. Equivalent annual net income[1] from tung for specified prices and eight percent interest rate.

	Cents per pound for tung oil				
Year	20	22	24	26	28
			(dollars per acre)		
2	—22.90	—22.90	—22.90	—22.90	—22.90
3	—20.04	—20.04	—20.04	—20.04	—20.04
4	—17.51	—17.13	—16.75	—16.38	—16.00
5	—15.63	—14.67	—13.70	—12.74	—11.77
6	—12.96	—11.26	—9.56	—7.86	—6.16
7	—10.30	—7.79	—5.29	—2.78	—0.27
8	—8.00	—4.77	—1.54	1.69	4.92
9	—5.95	—2.06	1.82	5.71	9.60
10	—4.28	0.15	4.58	9.00	13.43
11	—2.88	2.00	6.88	11.76	16.64
12	—1.70	3.57	8.84	14.10	19.37
13	—0.67	4.93	10.53	16.13	21.74
14	0.22	6.12	12.01	17.91	23.81
15	0.95	7.09	13.23	19.36	25.50
16	1.55	7.87	14.20	20.53	26.86
17	2.02	8.51	14.99	21.47	27.95
18	2.41	9.02	15.62	22.22	28.83
19	2.72	9.43	16.13	22.83	29.53
20	2.97	9.75	16.53	23.30	30.08
21	3.17	10.01	16.84	23.68	30.51
22	3.33	10.21	17.09	23.97	30.84
23	3.45	10.36	17.27	24.18	31.09
24	3.54	10.47	17.40	24.34	31.27
25	3.60	10.55	17.49	24.41	31.39
26	3.64	10.60	17.55	24.50	31.46
27	3.67	10.62	17.58	24.53	31.49
28	3.68	10.63	17.58	24.53	31.48
29	3.67	10.61	17.56	24.50	31.45
30	3.65	10.58	17.52	24.45	31.38
31	3.62	10.54	17.46	24.38	31.30

Source: Computed from data shown in Tables 2 and 4.

[1] Eqivalent annual net incomes were computed by compounding expenses and discounting revenues to adjust the net returns to annual income streams.

APPENDIX TABLES

Appendix Table 1. Prices paid for items of production.

Item	Unit	Price/unit
		($)
Tung trees	each	.10
Fertilizer:		
(10-20-10)	ton	71.00
(0-10-30)	ton	49.75
(16-8-16)	ton	71.50
Anhydrous ammonia 82%	ton	105.00
Ammonia nitrate 33%	ton	75.00
Superphosphate 20%	ton	34.00
Muriate potash 60%	ton	55.00

Appendix Table 2. Power and machinery: Estimated life, price, cost per hour of use and performance rates per acre.

Implement	Size or description	Total estimated life	Repair as a percent of new cost	Purchase price	Cost per hour of use				Performance rates per acre once over	Size of work crew
					Depreciation[1]	Repairs	Fuel, oil, grease	Total		
		(hrs.)	(percent)	($)	($)	($)	($)	($)	(hrs.)	(no.)
Tractor	40 h.p.	10,500	120	4,800	.41	.55	.50	1.46		-
Disk	7½'	900	60	625	.62	.42	.01	1.05	.5	1
Spring-tooth harrow	12'	750	50	475	.57	.32		.89	.25	1
Chain harrow	12'	750	50	225	.27	.15	----	.42	.5	1
Anhydrous ammonia applicator		1,500	30	650	.39	.13	...	.52	.25	1
One-way tiller	5½'	900	60	425	.42	.28	.01	.71	.5	1
Fertilizer distributor	16'	1.200	25	295	.22	.06	.01	.29	.5	1

[1] Assuming a ten percent salvage value.

Appendix Table 3. Labor and power requirements per acre for establishment of tung orchards.

Description of operation	Performance period	Hours/acre Man	Hours/acre Equip.	Cost per acre
		(hrs.)	(hrs.)	($)
Preparing land for plantings*		1.3	1.3	4.00
Planting trees		3.0	1.0	5.00
Cultivation		1.5	1.5	4.50
Pruning		1.0	0.0	1.00
Fertilizer application		1.0	0.0	1.00
Total				15.50

*Assuming land is already cleared.

Appendix Table 4. Materials required to establish one acre of tung.

Materials	Unit	Cost per unit	Units per acre	Cost per acre
		($)		($)
Tress	each	.10	125	12.50
Fertilizer (10-20-10)	lbs.	.0355	62.5	2.22
Total				14.72

Appendix Table 5. Labor and equipment requirements per acre for specified operations by age of tung trees.

Year	Disk L[2]	Disk E[3]	Spring tooth harrow L	Spring tooth harrow E	Hoe[1] L	Fertilize L	Fertilize E	Chain harrow L	Chain harrow E
					Hours per acre				
2	1.5	1.5	..		0.8	.50	.50	----	----
3	1.5	1.5	...		0.8	.50	.50	----	----
4	0.5	0.5	0.5	0.5	---	.50	.50	0.5	0.5
5	0.5	0.5	0.5	0.5		1.25	1.25	0.5	0.5
6	0.5	0.5	0.5	0.5	—	1.25	1.25	0.5	0.5
7	0.5	0.5	0.5	0.5	---	1.25	1.25	0.5	0.5
8	0.5	0.5	0.5	0.5		1.25	1.25	0.5	0.5
9	0.5	0.5	0.5	0.5	----	1.25	1.15	0.5	0.5
10	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
11	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
12	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
13	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
14	0.5	0.5	0.5	0.5	--	1.25	1.25	0.5	0.5
15	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
16	0.5	0.5	0.5	0.5	---	1.25	1.25	0.5	0.5
17	0.5	0.5	0.5	0.5		1.25	1.25	0.5	0.5
18	0.5	0.5	0.5	0.5	-	1.25	1.25	0.5	0.5
19	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
20	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
21	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
22	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
23	0.5	0.5	0.5	0.5	--	1.25	1.25	0.5	0.5
24	0.5	0.5	0.5	0.5	- -	1.25	1.25	0.5	0.5
25	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
26	0.5	0.5	0.5	0.5	--	1.25	1.25	0.5	0.5
27	0.5	0.5	0.5	0.5		1.25	1.25	0.5	0.5
28	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
29	0.5	0.5	0.5	0.5	-	1.25	1.25	0.5	0.5
30	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5
31	0.5	0.5	0.5	0.5	----	1.25	1.25	0.5	0.5

[1] Weed control is based upon hoeing orchards first two years and application of herbicide thereafter.

[2] Labor. [3] Equipment.

Appendix Table 6. Costs of labor and equipment for specified operations by age of tung trees.

Year	Disk		Spring tooth harrow		Hoe[1]	Fertilize[2]		Chain harrow		Total specified cost
	L[3]	E[4]	L	E	L	L	E	L	E	
					Dollars per acre					
2	1.88	3.76	-----	-----	1.00	.63	.88	-----	- -	8.15
3	1.88	3.76	-----	-----	1.00	.63	.88	-----	-----	8.15
4	0.63	1.26	0.63	1.18	1.00	.63	.88	0.63	0.94	7.78
5	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
6	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
7	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
8	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
9	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
10	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
11	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
12	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
13	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
14	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
15	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
16	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
17	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
18	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
19	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
20	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
21	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
22	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
23	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
24	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
25	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
26	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
27	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
28	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
29	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
30	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09
31	0.63	1.26	0.63	1.18	1.00	1.56	2.26	0.63	0.94	10.09

[1] After second year average annual cost is based on use of a herbicide to control weeds, application about every 3 years.

[2] For years 1-4 mixed fertilizer (10-20-10) was used, cost for other years includes cost of mixing fertilizer.

[3] Labor. [4] Equipment.

Appendix Table 7. Harvesting cost.

Item	Cost of first picking (85% of crop)	Cost of scrapping (15% of crop)
	($/ton)	($/ton)
Labor[1]	13.60	29.00
Sacks	1.25	1.25
Baskets	.25	.25
String	.10	.10
Tickets	.05	.05
Ramp out of orchard	2.00	2.00
Haul to mill	2.75	2.75
Total	20.00	35.40

[1] Including transportation of labor to and from work and cost of crew supervision and payroll preparation.

BULLETIN 734 JANUARY 1967

PHYSICAL AND CHEMICAL PROPERTIES OF FORESTED SOILS

By W. Frank Miller

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AGRICULTURAL EXPERIMENT STATION

HENRY H. LEVECK, Director

STATE COLLEGE MISSISSIPPI

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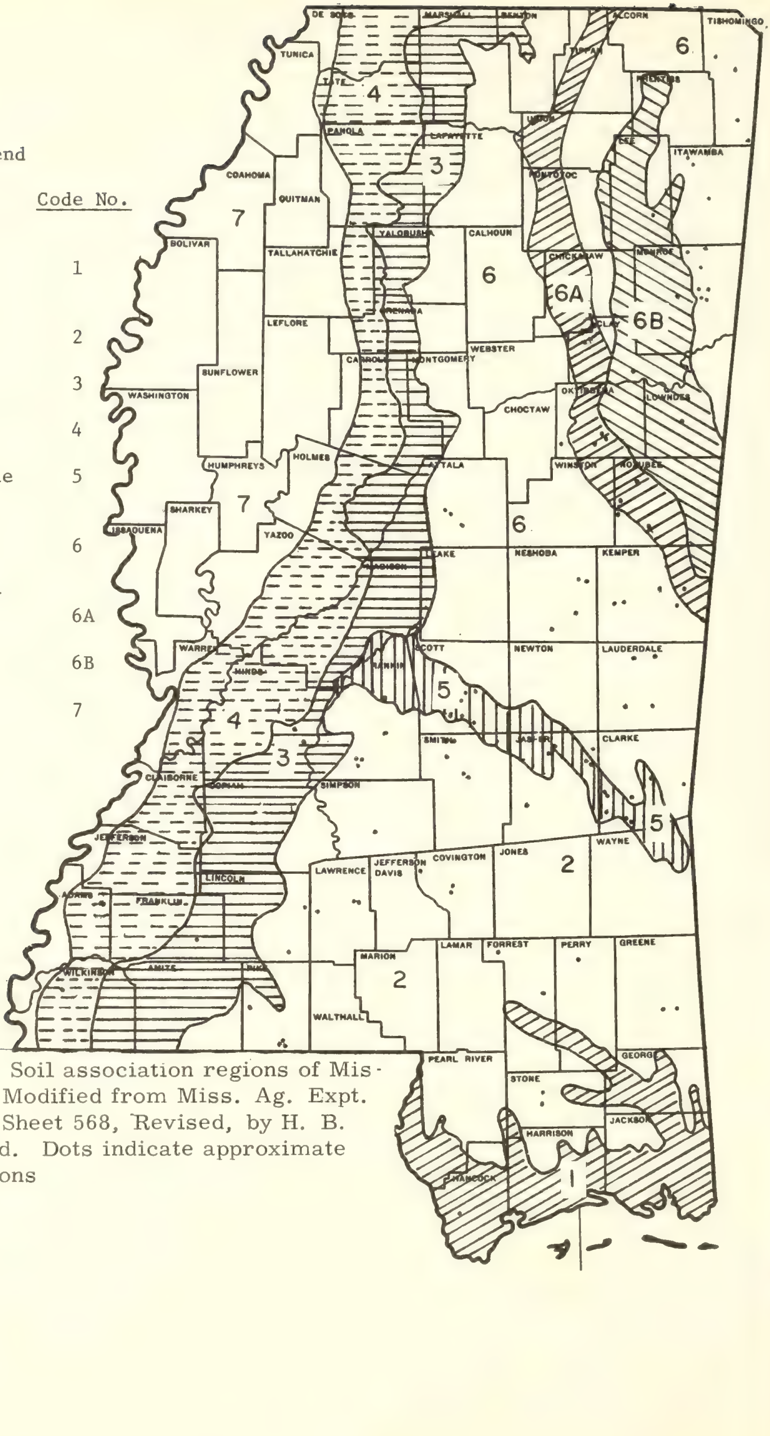
Legend

Region	Code No.
Coastal Flatwoods	1
Lower Coastal Plain	2
Thin Loess	3
Thick Loess	4
Central Prairie	5
Upper Coastal Plain	6
Interior Flatwoods	6A
Blacklands	6B
Delta	7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BENTON
ALCORN
TISHOMINGO
TUNICA
TIPPAH
6
TATE
4
PRENTISS
UNION
PANOLA
LAFAYETTE
LEE
3
ITAWAMBA
COAHOMA
PONTOTOC
QUITMAN
7
YALOBUSHA
CALHOUN
BOLIVAR
TALLAHATCHIE
CHICKASAW
MONROE
6
6A
6B
GRENADA
LEFLORE
CLAY
CARROLL
MONTGOMERY
WEBSTER
SUNFLOWER
WASHINGTON
OKTIBBEHA
LOWNDES
CHOCTAW
HOLMES
HUMPHREYS
ATTALA
WINSTON
NOXUBEE
7
SHARKEY
6
ISSAQUENA
YAZOO
LEAKE
NESHOBA
KEMPER
MADISON
WARREN
SCOTT
NEWTON
LAUDERDALE
HINDS
RANKIN
5
4
3
SMITH
JASPER
CLARKE
CLAIBORNE
COPIAH
SIMPSON
5
JEFFERSON
WAYNE
JONES
2
LAWRENCE
JEFFERSON DAVIS
COVINGTON
LINCOLN
ADAMS
FRANKLIN
LAMAR
FORREST
PERRY
GREENE
MARION
2
WILKINSON
AMITE
PIKE
WALTHALL
PEARL RIVER
GEORGE
STONE
JACKSON
HARRISON
HANCOCK
1

Figure 1. Soil association regions of Mississippi. Modified from Miss. Ag. Expt. Sta. Info. Sheet 568, Revised, by H. B. Vanderford. Dots indicate approximate plot locations

Physical and Chemical Properties of Forested Soils

By W. Frank Miller

INTRODUCTION

This bulletin deals with characteristics of most of the major soil series on which natural stands of loblolly pine (Pinus taeda L.) are found in the State of Mississippi. In 1959, the Forestry Department of the Mississippi Agricultural Experiment Station initiated a study of the relation between soil moisture regime and nutrient levels, and the productivity of loblolly pine. As data were compiled it became apparent that a large quantity of descriptive soil information could be made available from the original study. It was felt that with the addition of cation exchange and base saturation data, the information might aid in the classification of soils under the recently adopted Comprehensive Classification (1)[1], which requires laboratory analyses for differentiation between various Orders and Families.

Sampling Areas

Plots were located in eight of the nine soil association regions of the State; only the Delta region was not sampled (Table 1 and Figure 1). In general, sampling was confined to the eastern two-thirds of the State, and to soils of uplands and terraces.

Climate

The climate of Mississippi is described as warm temperate and humid. There is, however, a rather wide range in climatic conditions from north to south. Mean annual precipitation varies from 50 inches in the northwest to 64 inches in the south and mean annual temperatures from 62° F to 68°F. There is a two-month difference between the average date of the last spring day with a temperature of 32° F or lower and the first fall day with temperature of 32°F or lower (8).

Annual potential evapotranspiration, as calculated by the method of Palmer and Havens (10), is generally less than precipitation. Based on 27 weather stations scattered over the State, there is, however, an average total precipitation deficit of 7.40 inches during June, July, and August.

Geology and Soils

Ninety-eight profiles representing 25 soil series developed from 19 geologic sediments were sampled (Table 1). The designation of some soil parent materials is probably open to question, particularly those Pheba, Mashulaville, Vaiden, and Eutaw series described as developing from alluvium. Based on a hypothesis presented by Dr. E. E. Russell[2], it is the opinion of the author that many of the broad, flat ridges paralleling existing drainage lines are the result of resequent cutting into old flood plains which leave the flood plain remnants in a ridge position. This appears to be quite obvious in the case of the silty Pheba, Stough, and Mashulaville series capping the Porters Creek Formation of the Interior Flatwoods, and the acid clays such as Oktibbeha, Vaiden, and Eutaw over the chalk of the Blackland prairie.

In the case of sandy and clay loam alluvium deposited over older sediments, the situation is not as apparent as the silt over clay and the acid clay over calcareous clay. The alluvium occurs over two predominant land forms: subdued topography and moderately well, somewhat poorly

---

[1] Refers to literature cited.

[2] Personal communication from Dr. Russell, Assoc. Prof. of Geology, Miss. State University.

Table 1. Soil association regions and geologic parent materials from which samples were obtained.

Series	Land Use Areas	Parent Materials
Vaiden-Eutaw	Central Prairie	alluvium
Cahaba	Upper & Lower Coastal Plain	Cockfield & Citronelle Fm
Lexington	Thin Loess	loess Winona Fm
Falkner	Interior Flatwoods	Porters Creek Fm
Bude	Thin Loess	alluvium
Grenada	Upper Coastal Plain	loess
Loring	Thick & Thin Loess	loess
Henry	Thin Loess & Lower Coastal Plain	loess
Boswell	Upper & Lower Coastal Plain	Wilcox & Forest Hill Fm Hattiesburg Fm
Wilcox	Interior Flatwoods	Porters Creek Fm
Susquehanna	Lower Coastal Plain	Hattiesburg Fm
Eustic	Upper & Lower Coastal Plain	Cockfield & Citronelle Fm
Rumford	Upper & Lower Coastal Plain	Citronelle & Wilcox Fm colluvium
Stough	Upper Coastal Plain & Interior Flatwoods	Tuscahoma Fm, alluvium
Ruston	Upper Coastal Plain & Thin Loess	Citronelle, Meridian, Eutaw Tuscaloosa & Kosciusko Fm
Rains	Coastal Flatwoods	Pleistocene & Recent marine deposits
Ora	Upper & Lower Coastal Plain	Eutaw, Catahoula & Citronell Fm alluvium, colluvium
Savannah	Central Prairie, Upper & Lower Coastal Plain	Catahoula & Citronelle Fm alluvium, colluvium
Mashulaville	Upper & Lower Coastal Plain, Interior Flatwoods, Central Prairie	Forest Hill Fm, alluvium
Myatt	Upper & Lower Coastal Plain,	Recent alluvium
Pheba	Blacklands, Interior Flatwoods, Central Prairie, Upper & Lower Coastal Plain	Catahoula Fm, loess, alluvium
Luverne	Upper Coastal Plain	Tuscaloosa Fm
Cuthbert	Upper & Lower Coastal Plain, Blacklands	Hattiesburg & Eutaw Fm, Coffee Fm
Shubuta	Upper & Lower Coastal	Wilcox, Forest Hill, Neshob Cockfield, Catahoula & Eutaw

and poorly-drained soils with fragipans, or a well to excessively well-drained sandy mantle draped over older soils in rough, broken topography.

Professor T. H. Silker[3] has developed a hypothesis that many of these Coastal Plain soils, such as the Lakeland, Ruston, Troup, Bowie, Caddo, Boswell, Susquehanna, and Oktibbeha series, result from a Quaternary mantle deposit dropped over a formed landscape cut into antecedent geosynclinal strata. This presupposes a form of catastrophic deposition during the Quaternary period and considerable subsequent erosion that modified the depth of the surface sandy loam strata or completely stripped off all mantle to isolate some patches of Quaternary sediment (13). The Quaternary mantle is quite widespread and has been personally observed at locations from Mississippi to North Carolina.

METHODS AND PROCEDURES

Although no attempt was made to hold sample plot profiles to a modal concept for a soil series, a major criteria used for plot establishment was that of physical soil uniformity. The apparent physical soil properties and topographic situations were to be uniform on the plot and for a distance off plot equal to the height of the plot-edge trees. Large pits were excavated and samples collected from each major horizon, or horizon group; *i. e.*, if a horizon such as an A_{11} was too thin to be sampled separately, it was included in a composite sample with the A_{12}.

Undisturbed soil cores for moisture properties description were collected in brass rings with a volume of approximately 30 cc at the rate of 14 cores per horizon. Brass cores with a volume of 64.35 cc were used to obtain a bulk density sample in the manner described by Garey (3), and a bulk sample for use in mechanical and chemical analyses was also collected from each horizon.

Physical Analyses

Particle size analysis was performed by a hydrometer method. The hydrometer reading for percent clay less than two microns was taken after 8 hours of settling, and the sand fraction was determined by sieving the dispersed soil material. The silt fraction, two to 50 microns, was obtained by difference.

Soil moisture data were obtained as follows: a tension of 60 cm of water was applied by the use of a tension table (7), ⅓, ⅔, and 1 bar of pressure by means of a porous plate apparatus, and the 4 and 15 bar pressures by means of a pressure membrane apparatus (12). The moisture percentages, by weight, obtained at the various tensions, were multiplied by the respective horizon bulk densities to obtain percent moisture by volume.

Chemical Analyses

The chemical analyses were made in two stages; the initial data on pH, available phosphorus, exchangeable potassium, and organic matter were obtained by the Soil Testing Laboratory of the Extension Service, and cation exchange capacity, exchangeable hydrogen, and exchangeable cations were obtained by the Chemistry Department of the Experiment Station.

Soil acidity was determined by a glass electrode method using a 2:1 water-soil ratio. Available phosphorus was obtained colorimetrically (5), and exchangeable potassium by means of a flame photometer (6); the values for both were converted to pounds per acre-inch by multiplying the weight of an acre-inch of water by the horizon bulk density, then multiplying by the parts per million of the element.

Soil organic matter was obtained by means of digestion with a standard potassium dichromate solution and colorimetric determination of the reduced chromate. Exchange capacity was determined by the standard A.O.A.C. procedure (2), exchangable hydrogen by the method of Peech, *et. al.* (11), and exchangeable cations by the methods of Jackson (4).

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[3] Personal communication with Assistant Professor Silker, Forestry Department, Oklahoma State University, Stillwater, Oklahoma.

RESULTS

A detailed discussion of the general properties of each series has not been attempted due to the state of flux of soil classification under the new system. Instead, a series of tables are presented to summarize the data. Table 2 indicates the series name, classification, and composition of the control section or family name; average solum values for sand, clay, organic matter, cation exchange capacity, base saturation, and soil moisture available between 1/10 and 15 bars of tension are presented in Table 3 for series in which more than one profile was sampled, and Table 4 compares the same values by horizons between series.

The remaining tables present the results of the various analyses by individual profiles.[4] It should be noted that in these tables some moisture data is given on a

Table 2. Summary of soil series sampled, their classification and composition of the control sections (family name).

Series	Classification	Control Section
Vaiden	Aquic Entic Chromudert	Montmorillonitic, thermic, acid
Eutaw	Typic Pelludert	Montmorillonitic, thermic, acid
Lexington	Ultic Normudalf	Fine-silty, mixed, thermic
Falkner	Aquultic Paleudalf	Fine-silty, mixed, thermic
Bude	Aqueptic Fragiudalf	Fine-silty, mixed, thermic
Grenada	Ochreptic Fragiudalf	Fine-silty, mixed, thermic
Loring	Typic Fragiudalf	Fine-silty, mixed, thermic
Henry	Typic Fragiaqualf	Fine-silty, mixed, thermic
Boswell	Vertic Paleudalf	Fine, montmorillonitic, thermic
Wilcox	Vertic Paleudalf	Fine, montmorillonitic, thermic
Susquehanna	Vertic Paleudalf	Fine, montmorillonitic, thermic
Eustis	Pasmmentic Hapludult	Sandy, siliceous, thermic
Rumford	Typic Hapludult	Coarse-loamy, siliceous, thermic
Stough	Aquic Fragiudult	Coarse-loamy, siliceous, thermic
Cahaba	Typic Hapludult	Fine-loamy, siliceous, thermic
Ruston	Typic Paleudult	Fine-loamy, siliceous, thermic
Rains	Typic Ochraquult	Fine-loamy, siliceous, thermic
Ora	Typic Fragiudult	Fine-loamy, mixed, thermic
Savannah	Typic Fragiudult	Fine-loamy, mixed, thermic
Mashulaville	Typic Fragiaquult	Fine-loamy, mixed, thermic
Myatt	Typic Ochraquult	Fine-loamy, mixed, thermic
Pheba	Aqueptic Fragiudult	Fine-silty, mixed, thermic
Luverne	Typic Paleudult	Clayey, kaolinitic, thermic
Cuthbert	Paraquic Hapludult	Clayey, kaolinitic, thermic
Shubuta	Typic Hapludult	Clayey, mixed, thermic

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[4] Profiles are grouped by Order; Tables 5 through 9 represent profiles in the Order Vertisols, Tables 10 through 28 the Alfisols, and Tables 29 through 93 the Order Ultisols.

disturbed sample basis; based on unpublished results from this same general study, the following formulae can be used to convert the values to percent by volume on an undisturbed sample basis:

A horizons: Pv Undisturbed = 4.80 + 0.6725 (Pv Disturbed)
B horizons: Pv Undisturbed = 6.14 + 0.6264 (Pv Disturbed)
1/10 bar
A horizons: Pv Undisturbed = 2.50 + 1.0431 (Pv Disturbed)
B horizons: Pv Undisturbed = 3.40 + 0.9954 (Pv Disturbed)
15 bars

All prediction equations are significant at the 1% level.

The last group of profiles (Tables 94 through 102) were included to illustrate the problems in classification that are encountered when sampling is not held to a modal concept. These profiles, although given a series name, do not fit the current description for that particular series of classification.

Table 3. Average solum properties, weighted by horizon thickness.

Series	cation exchange capacity	base saturation metals/cations	available water 1/10 bar-15 bars	organic matter	available phosphorus	exchangeable potassium
	meq./100g	%	%	%	#/acre-inch	#/acre-inch
Vaiden-Eutaw	30.3	53.8	.170	1.9	0.24	23.7
Lexington	9.9	43.1	.185	1.1	0.45	34.7
Falkner	20.9	28.3	.136	1.3	0.23	21.8
Bude	9.5	13.3	.173	0.7	0.19	9.5
Grenada	8.6	30.3	.218	1.1	0.33	20.2
Loring	13.5	37.4	.166	1.3	0.32	23.1
Henry	10.2	29.5	.240	1.4	0.25	10.9
Boswell	27.6	40.8	.181	1.2	0.28	27.1
Wilcox	31.3	46.6	.232	1.2	0.81	43.6
Susquehanna	26.8	58.9	.132	1.2	0.25	34.0
Eustis	1.8	25.9	.076	0.6	2.05	2.5
Rumford	5.2	18.9	.133	0.8	0.38	16.1
Stough	6.6	23.8	.187	1.0	0.41	8.5
Cahaba	4.8	31.2	.126	0.5	0.67	8.8
Ruston	5.9	23.2	.118	0.7	0.75	16.2
Rains	5.3	4.6	.242	1.5	0.41	1.7
Ora	6.8	22.8	.145	0.7	0.46	13.5
Savannah	6.4	21.9	.157	0.8	0.49	8.3
Mashulaville	6.5	24.2	.206	0.9	0.55	7.2
Myatt	7.5	18.5	.189	1.3	0.65	12.0
Pheba	7.6	22.5	.202	1.2	0.30	8.2
Luverne	5.9	9.4	.084	0.6	0.24	7.2
Cuthbert	26.5	40.7	.128	0.8	0.43	30.3
Shubuta	14.9	31.1	.116	1.0	0.43	24.8

Table 4. Summary of selected soil properties by horizon and series.

	A_1 Horizon						B_2 Horizon					
Series	CEC	B. S.	AWHC	O. M.	P.	K.	CEC	B. S.	AWHC	O. M.	P.	K.
	meq.	%	in./in.	%	#/ac.in.	#/ac.in.	meq.	%	in./in.	%	#/ac.in.	#/ac.
Vaiden-Eutaw	24.4	49.8	.147	4.7	0.39	17.9	27.6	52.2	.124	1.8	0.23	17.0
Loring	13.5	56.7	.217	2.7	0.99	37.7	14.7	41.7	.129	0.7	0.14	20.9
Henry	11.1	38.5	.248	4.0	0.54	10.1	9.5	36.8	.277	0.6	0.04	21.9
Boswell	16.5	32.6	.158	2.8	0.48	13.9	26.6	45.3	.135	1.3	0.20	30.2
Wilcox	24.6	51.3	.172	3.0	0.70	30.7	29.1	37.2	.154	0.9	0.31	32.8
Eustis	2.7	19.5	.081	1.5	5.95	2.8	----	----	----	---	----	-----
Stough	6.6	35.6	.202	2.4	0.73	8.8	5.5	24.4	.144	0.6	0.31	6.2
Cahaba	3.4	25.0	.135	0.9	1.53	8.0	6.7	31.7	.118	0.3	0.26	10.8
Ruston	2.1	20.9	.150	0.6	2.27	4.5	7.7	28.5	.092	0.3	0.33	26.8
Ora	4.3	24.3	.160	1.6	0.71	8.8	7.4	26.8	.116	0.4	0.48	18.5
Savannah	6.3	21.7	.169	2.1	0.91	6.2	5.9	20.8	.171	0.5	0.34	9.8
Mashulaville	5.9	19.2	.217	2.6	1.05	7.4	4.5	27.3	.205	0.5	0.21	4.0
Myatt	9.5	20.5	.186	3.2	1.29	17.7	5.1	15.4	.191	0.8	0.47	9.7
Pheba	8.8	24.0	.195	2.8	0.53	8.7	6.5	27.9	.200	0.7	0.25	7.6
Cuthbert	16.6	50.3	.147	1.5	0.87	31.6	27.3	32.2	.099	0.6	0.37	27.2
Shubuta	4.8	24.4	.142	2.1	0.59	6.8	16.1	37.3	.089	0.8	0.23	30.6

CEC: cation exchange capacity - meq./100gm
B. S.: base saturation, metals/cations - percent
AWHC: available water holding capacity, percent by volume at 1/10 bar minus percent by volume at 15 bars
O. M.: organic matter - percent
P.: available phosphorus - pounds per acre-inch
K.: exchangeable potassium - pounds per acre-inch

Order 2. Vertisols

Common characteristics of this group of soils include a high percentage of montmorillinitic clays (greater than 35%), greater than 30 meq. of exchange capacity in horizons below the A, and the presence of rather large cracks in the soils during dry periods. Only two series are represented here, the Vaiden and Eutaw soils. Although occurring extensively in the Blackland Prairie area, the particular profiles sampled were found in the Central Prairie where a much greater percent of the area is in soils of this type.

While calcareous soils do not support a pine community, these acid clays overlying the chalk are almost invaribaly pine sites if they had been disturbed in the past. The site index of the soils is quite uniform, ranging from 77 feet to 87 feet at age 50 years, with an average of 84 feet. Site index is defined in this study as the average total height of the dominant stems in a stand at a reference age of 50 years. These soils do, however, present a problem in pine maintenance due to the abundance of hardwood species such as water oak (Quercus nigra, L.), willow oak (Q. phellos, L.), and red maple (Acer rubrum, L.), which are quite resistant to control by foilage-applied herbicides.

It is quite difficult to evaluate, even qualitatively, soil families or even soil series on the basis of control of undesirable hardwoods because of this factor. Site undoubtedly plays a very significant role in determining stand composition, but so also do cutting practices and past stand history. Consequently, only generalities are attempted in this report. Regeneration potential[5] on these soils is usually quite good.

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[5] The estimated capacity of a site to provide a suitable environment for survival and growth of seedlings; based primarily on physical soil conditions as they influence moisture storage and release.

Table 5: SERIES Vaiden sil

Location: County Clarke Town Shubuta	Aspect: S-10-E
Region: Central Prairie	Slope %: 2
Position: Lower 1/3 slope	Drainage: Somewhat poorly
Elevation: 300'	Parent Material: Alluvium over Jackson fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 3	26.2	52.2	21.6	sil	3.41	0.37	13.27
2	BP$_{2g}$	3-11	12.6	37.0	50.4	c	1.45	0.03	14.54
3	B$_{3g}$	11-24	12.0	34.9	53.1	c	0.78	0.03	17.10
4	C$_{2g}$	24-56	9.6	29.8	60.6	c	0.70	0.03	24.14

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.7	17.9	6.6	2.1	0.1	0.2	11.0	50.28	45.00
2	4.8	29.4	9.4	3.2	0.2	0.3	16.3	44.56	44.56
3	4.9	31.3	11.6	3.6	0.3	0.3	16.1	50.48	49.53
4	4.8	35.9	19.3	4.5	0.8	0.4	13.5	69.64	64.94

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.26	37.7	34.4	28.4	27.2	24.9	22.4	20.7
2	1.38	40.1	36.6	35.5	34.3	33.4	32.8	32.0
3	1.48	48.7	48.8	46.9	44.1	41.7	38.6	34.9
4	1.45	56.3	57.0	53.7	50.6	49.2	44.7	40.7

Table 6: SERIES Vaiden sicl

Location: County Scott
Town Forest
Region: Central Prairie
Position: Upper 1/3 slope
Elevation: 450'

Aspect: N-35-W
Slope %: 5
Drainage: Somewhat poorly
Parent Material: Alluvium over Jackson fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 3	8.5	57.9	33.6	sicl	5.46	0.28	22.40
2	B_{2g}	3- 8	6.3	57.8	35.9	sicl	1.33	0.27	17.43
3	B_{3g}	8-27	1.3	28.9	69.8	c	0.86	0.13	37.69
4	C_{2g}	27-55	1.1	31.7	67.2	c	0.62	0.14	52.19

CHEMICAL DATA

		C.E.C.,	Exchangeable cations, me./100g.					% Base Saturation	
No.	pH	me./100g.	Ca	Mg	Na	K	H	metals/C.E.C.	metals/cations
1	5.0	31.3	12.2	4.8	0.2	0.4	15.4	56.23	53.33
2	5.0	23.0	8.8	3.7	0.2	0.3	12.1	56.52	51.79
3	4.7	42.8	18.6	8.6	0.6	0.6	17.3	66.36	62.14
4	5.1	41.0	11.6	7.7	1.2	0.8	10.8	51.95	66.36

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.96	32.5	31.6	30.5	27.9	27.5	24.5	23.8
2	1.35	38.8	36.2	34.5	31.7	29.1	27.0	24.3
3	1.28	57.3	55.2	50.1	47.9	46.9	46.0	40.9
4	1.44	59.2	57.8	51.3	49.1	48.3	47.4	44.2

Table 7: SERIES Vaiden sil

Location: County Rankin	Aspect: N-55-E
Town Langford	Slope %: 1
Region: Central prairie	Drainage: Somewhat poorly
Position: Ridge flat	Parent Material: Alluvium over Jackson fm
Elevation: 345'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 5	20.5	68.1	11.4	sil	2.08	0.45	9.04
2	B_{2g}	5-15	8.8	45.7	45.5	sic	0.78	0.41	18.08
3	B_{3g}	15-25	6.1	37.2	56.7	c	0.46	0.14	20.41
4	C_{2g}	25-35	6.0	40.2	53.8	c	0.46	0.15	28.39
5	IID_{2g}	35-56	7.1	47.6	45.3	sic	0.55	0.16	27.54

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.2	10.3	3.9	1.1	0.1	0.1	6.8	50.49	43.33
2	5.2	34.5	15.2	4.6	0.4	0.3	15.5	59.42	56.94

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.14	33.4	31.8	23.2	15.7	10.9	8.6	5.5
2	1.40	49.8	46.4	41.7	39.4	36.6	30.9	27.5
3	1.43	57.6	57.1	52.0	49.1	45.8	42.6	34.2
4	1.51	56.3	55.4	52.3	50.4	49.4	43.6	3.4
5	1.60	57.0	55.6	52.0	48.0	44.2	40.7	39.9

Table 8: SERIES Eutaw sicl

Location: County Scott
Town Forest
Region: Central Prairie
Position: Ridge flat
Elevation: 475'

Aspect: North
Slope %: 0
Drainage: Poorly drained
Parent Material: Alluvium over Jackson fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 3	7.8	62.6	29.6	sicl	7.08	0.32	19.63
2	B_{2g}	3- 8	7.5	61.7	30.8	sicl	3.00	0.12	14.89
3	C_{1g}	8-35	4.2	55.8	40.0	sic	0.70	0.03	13.14
4	C_{2g}	35-88	2.9	40.9	56.2	sic	0.46	0.15	33.98

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	26.0	13.0	2.7	0.2	0.3	15.3	62.31	51.43
2	5.3	20.8	10.6	2.4	0.1	0.2	10.6	63.94	55.65
3	4.7	24.3	7.2	1.9	0.2	0.2	17.3	39.09	35.45
4	5.0	34.5	17.5	5.0	0.8	0.5	13.8	68.99	63.30

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.07	39.8	37.3	35.1	30.2	29.3	27.3	21.2
2	1.24	41.6	39.2	36.1	32.0	30.3	28.5	23.0
3	1.45	44.7	40.8	38.3	35.9	35.0	33.1	31.2
4*	1.50		56.4	43.9	40.0	37.1	30.3	25.1

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*Disturbed sample

Table 9: SERIES Eutaw sicl

Location: County Jasper
Town Montrose
Region: Central Prairie
Position: Lower 1/3 slope
Elevation: 500'

Aspect: N-75-E
Slope %: 1
Drainage: Poorly drained
Parent Material: Alluvium over Jackson fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 3	11.0	50.1	38.9	sicl	5.56	0.53	25.18
2	B_{2g}	3- 9	10.8	49.2	40.0	sic	2.35	0.34	19.97
3	C_{1g}	9-18	3.7	36.3	60.0	c	1.05	0.38	28.12
4	C_{2g}	18-68	2.4	25.2	72.4	c	0.55	0.53	41.43

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	36.6	16.9	4.8	0.2	0.5	17.6	61.20	56.00
2	5.1	30.1	11.3	3.8	0.2	0.4	14.4	52.16	52.16
3	4.9	34.8	12.0	4.9	0.3	0.5	21.8	50.86	44.81
4	5.0	40.8	23.8	8.8	0.8	0.7	13.0	83.58	72.40

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.90	36.4	33.8	32.1	30.6	30.0	28.0	24.1
2	1.16	39.4	37.4	34.9	32.9	32.9	31.9	27.1
3	1.28	52.5	49.7	47.1	44.7	42.4	35.6	31.5
4	1.34	58.1	56.1	52.8	50.9	50.7	49.4	44.5

Order 7. Alfisols

This Order is characterized by mineral soils which are usually moist and have a textural B horizon, or a natric horizon, with a base saturation of more than 35% based on the sum of cations. Three families are represented by profiles in this section—the fine-loamy, siliceous, thermic, the fine-silty, mixed, thermic, and the fine, montmorillinitic family.

Intra-family variation in site index is appreciable, as are both hardwood control problems and regeneration potential. The three profiles in the fine-loamy, siliceous, thermic family supported loblolly pine stands that ranged from 79 feet to 96 feet in site index. Approximately four feet of the 17-foot difference can be accounted for by climatic variation (9).

Undesirable hardwood control is not usually a major problem unless the stand understory contains a large amount of dogwood (Cornus, spp.) and red maple, and the regeneration potential is moderately good. The fine-silty family, however, is a better regeneration chance although hardwood control problems are more severe due to a larger number of hardwood of low susceptibility to herbicides; the site index within this family ranges from 73 feet to 100 feet.

Perhaps the most variable family is the fine, montmorillinitic group represented here by Boswell, Wilcox, and Susquehanna soils. The regeneration potential ranges from excellent on most Wilcox soils to occasionally poor on eroded Boswell soils, while the hardwood problem ranges from servere on some Wilcox soils to moderate on Susquehanna and Boswell soils. The site index within the family ranges from 74 feet to 92 feet.

Table 10: SERIES Lexington sil

Location: County Attala
Town Kosciusko
Region: Thin Loess
Position: Upper 1/3 slope
Elevation: 470'

Aspect: N-30-W
Slope %: 7
Drainage: Well
Parent Material: Loess over Winona fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A & B	0- 4	22.4	69.2	8.4	sil	3.13	0.59	15.29
2	B_2	4-11	12.4	61.6	26.0	sil	0.55	0.49	43.58
3	B_3	11-30	9.4	62.2	28.4	sicl	0.38	0.21	49.37
4	IIC_1	30-74	39.2	45.2	15.6	l	0.18	0.49	30.46

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.4	9.1	3.2	1.8	0.1	0.3	7.3	59.34	45.52
2	5.2	11.4	3.1	3.8	0.1	0.5	7.8	65.79	49.02
3	5.2	11.9	1.4	4.4	0.1	0.5	9.0	53.78	41.56
4	5.2	7.3	0.2	2.8	0.1	0.2	5.8	45.21	36.26

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.00	31.5	27.5	25.1	20.8	19.5	16.0	9.7
2	1.42	37.6	34.8	32.9	27.0	24.5	23.9	17.8
3	1.42	43.6	37.7	36.5	29.9	25.8	24.4	18.7
4	1.66	36.9	33.9	30.8	25.3	23.1	17.8	13.7

Table 11: SERIES Falkner sil

Location: County Oktibbeha
Town State College
Region: Upper Coastal Plain - Interior Flatwoods
Position: Ridge
Elevation: 300'

Aspect: S-80-E
Slope %: 2
Drainage: Somewhat poorly
Parent Material: Porter's Creek fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

			Particle size dist.,%				Organic Matter	lbs. per acre inch	
No.	Horizon	Depth, in.	Sand	Silt	Clay	Texture	%	Avail.P	Exch.K
1	A_p	0- 4	22.6	60.8	16.6	sil	3.69	0.51	24.26
2	B_{21g}	4-15	12.6	53.6	33.8	sicl	1.05	0.03	20.49
3	B_{22g}	15-22	11.3	54.2	34.5	sicl	0.46	0.03	19.78
4	B_{31g}	22-30	14.0	52.4	33.6	sicl	0.55	0.28	22.83
5	B_{32g}	30-46	13.8	53.8	32.4	sicl	0.55	0.29	21.85

CHEMICAL DATA

			Exchangeable cations, me./100g.					% Base Saturation	
No.	pH	C.E.C., me./100g.	Ca	Mg	Na	K	H	metals/C.E.C.	metals/cations
1	5.2	19.5	4.8	3.6	0.1	0.3	12.6	45.13	41.12
2	4.8	20.8	1.6	3.4	0.1	0.3	16.9	25.96	24.22
3	4.9	22.1	1.1	3.5	0.1	0.3	17.3	22.62	22.42
4	4.8	22.5	1.1	3.6	0.2	0.4	17.7	23.56	23.04
5	4.7	19.6	2.2	3.8	0.4	0.3	15.0	34.18	30.88

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.04	38.8	37.4	34.0	29.4	23.9	21.4	16.3
2	1.35	44.1	38.9	35.1	32.3	29.7	27.1	24.7
3	1.42	40.1	37.3	36.5	33.4	32.8	28.0	27.4
4	1.40	41.0	37.8	35.8	34.5	32.3	27.3	26.9
5	1.44	41.0	37.2	35.8	32.1	30.5	27.5	25.4

Table 12: SERIES Bude si

Location: County Amite Town Smithdale	Aspect: S-70-E
	Slope %: 3
Region: Thin Loess	Drainage: Somewhat poorly
Position: Ridge flat	Parent Material: Alluvium over Hattiesburg fm
Elevation: 450'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 7	12.2	83.4	4.4	si	1.25	0.40	5.26
2	B^{p}_{2g}	7-18	6.6	61.6	31.8	sicl	0.62	0.01	11.27
3	B_{3xg}	18-32	10.7	61.7	27.6	sil	0.25	0.15	12.07

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.6	5.4	0.2	0.1	0.0	0.1	6.4	7.41	5.88
2	5.0	11.6	0.2	2.0	0.1	0.2	11.4	21.55	17.99
3	5.0	11.6	0.2	1.5	0.2	0.1	10.5	17.24	16.00

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.16	37.1	31.7	25.1	16.4	13.3	11.0	7.0
2	1.26	39.3	33.6	30.3	29.3	27.9	22.7	20.8
3	1.48	43.8	37.8	37.4	33.2	32.0	29.7	23.5

Table 13: SERIES Grenada sil

Location: County Attala Town Williamsville	Aspect: N-20-E
Region: Upper Coastal Plain	Slope %: 3
Position: Upper 1/3	Drainage: Moderately well
Elevation: 450'	Parent Material: Loess over Winona fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 6	12.1	77.3	10.6	sil	2.47	0.71	19.03
2	B_2	6-20	7.0	69.9	23.1	sil	0.55	0.14	23.00
3	B_{3xg}	20-56	7.8	66.2	26.0	sil	0.38	0.14	18.43

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.4	8.8	3.2	1.1	0.1	0.2	6.9	52.27	40.00
2	4.9	8.0	1.3	1.3	0.1	0.2	7.8	36.25	27.10
3	5.1	9.0	0.7	1.5	0.1	0.2	8.0	27.78	23.81

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.20	44.5	41.4	33.1	30.7	24.8	20.5	7.9
2	1.41	43.8	39.5	31.2	24.7	21.8	18.7	15.7
3	1.44	40.1	37.1	33.1	28.5	25.6	21.6	18.1

Table 14: SERIES Loring sil

Location: County Benton	Aspect: N-65-W
Town Michigan City	Slope %: 2
Region: Thick Loess	Drainage: Moderately well
Position: Middle 1/3 slope	Parent Material: Loess
Elevation: 525'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	6.4	77.6	16.0	sil	2.75	0.68	31.10
2	$B_{21}t$	4-12	1.8	73.3	24.9	sil	0.78	0.03	25.32
3	$B_{22}t$	12-19	2.5	76.4	21.1	sil	0.46	0.14	17.52
4	A'_2	19-21	3.2	80.3	16.5	sil	0.38	0.28	15.94
5	B'_{2t}	21-31	4.7	76.3	19.0	sil	0.55	0.03	14.37

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	11.3	2.5	2.5	0.1	0.3	9.4	47.79	36.49
2	4.8	14.6	0.5	3.6	0.1	0.3	11.1	30.82	28.85
3	5.0	14.1	0.3	3.7	0.3	0.2	11.5	31.91	28.13
4	5.1	13.0	0.3	3.6	0.3	0.2	10.3	33.85	29.93
5	5.1	12.8	0.3	5.3	0.4	0.2	8.9	48.44	41.06

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.38		41.2	37.7			25.1	21.4
2	1.30		40.0	36.0			26.5	25.3
3	1.36		40.0	38.6			26.5	22.3
4	1.38		39.8	38.7			25.9	20.8
5	1.51		38.1	36.0			27.9	23.8

Table 15: SERIES Loring si

Location: County Hinds
Town Byram
Region: Thin Loess
Position: Upper 1/3 slope
Elevation: 300'

Aspect: N-35-W
Slope %: 6
Drainage: Moderately well
Parent Material: Loess

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 8	3.6	87.6	8.8	si	2.47	0.85	67.84
2	B_{21}	8-17	3.0	63.7	33.3	sicl	0.95	0.03	35.54
3	B_{22}	17-23	4.7	68.5	26.8	sil	0.78	0.03	20.03
4	A'_2	23-27	3.1	72.7	24.2	sil	0.55	0.03	13.90
5	B'_2	27-46	2.9	74.1	23.0	sil	0.62	0.03	16.40

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.0	9.0	2.6	1.1	0.1	0.6	7.8	48.89	36.07
2	4.7	15.8	3.2	2.1	0.2	0.4	12.8	37.34	31.55
3	4.7	15.0	2.6	2.0	0.3	0.2	12.1	34.00	29.65
4	5.1	14.6	2.1	1.8	0.6	0.2	11.3	32.19	29.38
5	5.0	15.4	2.8	2.0	0.8	0.2	10.5	37.66	35.58

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.22		29.1	23.0			11.4	6.5
2	1.42		35.7	34.8			32.5	30.7
3	1.32		35.3	33.4			26.7	23.6
4	1.32		34.0	34.4			23.8	21.1
5	1.42		25.3	35.4			26.0	23.1

Table 16: SERIES Loring sil

Location: County Wilkinson
Town Woodville
Region: Thick Loess
Position: Lower 1/3
Elevation: 275'

Aspect: S-40-W
Slope %: 6
Drainage: Moderately well
Parent Material: Loess

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 2	6.0	78.7	15.3	sil	4.15	0.75	15.50
2	A_2	2- 6	3.6	74.4	22.0	sil	0.86	0.20	16.89
3	B_{2tg}	6-22	14.6	61.0	24.4	sil	0.46	0.13	21.25
4	B_{3xg}	22-64	8.9	74.1	17.0	sil	0.32	0.18	12.92

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.4	19.3	7.0	2.7	0.2	0.2	13.0	52.33	43.72
2	5.5	15.1	7.3	3.5	0.1	0.2	7.5	73.51	59.68
3	5.2	14.9	5.4	3.9	0.2	0.2	9.0	65.10	51.87
4	5.1	10.3	2.4	2.4	0.3	0.2	7.3	51.46	42.06

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.16	52.2	48.5	41.9	39.8	36.6	34.8	22.4
2	1.32	38.4	36.5	33.9	30.9	26.7	24.5	18.2
3	1.34	39.5	35.3	30.5	27.3	23.5	18.5	16.1
4	1.40	40.3	34.3	27.6	23.5	20.3	15.7	10.9

Table 17: SERIES Loring sil

Location: County Hinds	Aspect: S-45-E
Town Raymond	Slope %: 2
Region: Thin Loess	Drainage: Moderately well
Position: Ridge flat	Parent Material: Loess
Elevation: 350'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 2	10.8	85.4	3.8	sil	5.56	1.68	36.36
2	A_2	2- 5	3.9	86.1	10.0	si	1.45	0.14	24.03
3	B_{2t}	5-27	1.6	63.8	34.6	sicl	0.78	0.77	23.85
4	A'_2	27-30	2.9	78.0	19.1	sil	0.55	0.14	14.85
5	B'_2	30-44	2.3	78.6	19.9	sil	0.55	0.03	14.46

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	6.2	14.3	8.6	2.0	0.1	0.4	8.0	77.62	58.12
2	5.0	6.0	0.7	0.8	0.1	0.2	6.4	30.00	21.95
3	4.9	16.4	1.5	4.5	0.2	0.3	12.8	39.63	33.68
4	4.9	11.9	0.8	2.8	0.3	0.2	9.4	34.45	30.37
5	5.1	13.0	1.5	4.4	0.4	0.2	8.5	50.00	43.33

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.92		31.4	29.0			15.3	13.4
2	1.36		33.5	29.5			13.1	8.0
3	1.30		36.0	35.7			29.4	27.0
4	1.41		39.3	34.2			21.6	17.2
5	1.52		39.0	40.2			29.0	23.8

Table 18: SERIES Henry sil

Location: County Rankin Town Thomasville	Aspect: N-40-W
Region: Lower Coastal Plain	Slope %: 2
Position: Ridge flat	Drainage: Poorly
Elevation: 310'	Parent Material: Loess

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 5	17.8	75.0	7.2	sil	3.86	0.40	12.86
2	B_{31xg}	5-20	13.3	73.4	13.3	sil	0.46	0.66	10.93
3	B_{32xg}	20-27	12.7	72.4	14.9	sil	0.38	0.14	13.50
4	C_{1g}	27-49	9.4	59.8	30.8	sicl	0.32	0.14	25.57

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.2	9.3	2.4	1.2	0.1	0.2	9.4	41.94	29.32
2	5.1	8.1	1.5	0.8	0.3	0.1	8.0	33.33	25.23
3	5.1	8.6	1.3	0.9	0.3	0.1	8.3	30.23	23.85
4	5.4	18.0	2.2	0.8	1.3	0.3	14.0	25.56	24.73

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.88	38.8	37.0	29.8	24.6	22.3	21.4	19.8
2	1.34	37.5	33.8	28.7	20.7	16.1	14.3	11.8
3	1.37	40.0	35.8	30.6	21.2	18.0	15.3	11.7
4	1.42	43.8	40.4	36.3	32.8	36.0	27.2	20.6

Table 19: SERIES Henry sil

Location: County Pike Town Magnolia	Aspect: South
Region: Thin Loess	Slope %: 1
Position: Ridge flat	Drainage: Poorly
Elevation: 350'	Parent Material: Loess

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A & B	0- 6	13.6	78.5	7.9	sil	2.08	0.47	5.35
2	B_{3xg}	6-22	11.1	73.3	15.6	sil	0.32	0.21	5.18
3	C_{1g}	22-38	9.9	68.9	21.2	sil	0.32	Trace	7.07

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.1	8.1	1.0	0.5	0.1	0.1	7.4	20.99	18.68
2	5.1	6.5	0.3	0.5	0.2	0.1	6.1	16.92	15.28
3	5.5	8.8	0.2	0.6	0.9	0.1	8.1	20.45	18.18

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.18	43.1	39.1	31.5	23.5	18.4	15.1	8.8
2	1.43	44.2	41.2	32.4	24.2	19.8	16.7	10.7
3	1.56	42.1	37.3	35.1	31.1	27.0	22.1	19.8

Table 20: SERIES Henry sil, c. loamy variant

Location: County Rankin Town Thomasville	Aspect: North
Region: Lower Coastal Plain	Slope %: 1
Position: Lower 1/3 flat	Drainage: Poorly
Elevation: 350'	Parent Material: Loess

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_{1g}	0- 1	21.0	73.9	5.1	sil	6.04	0.76	11.98
2	A_{2g}	1- 6	15.9	79.1	5.0	sil	1.33	0.13	5.68
3	B_{1g}	6-14	14.2	77.0	8.8	sil	0.55	0.03	4.28
4	B_{2xg}	14-32	13.0	74.3	12.7	sil	0.62	0.03	6.54
5	C_g	32+	11.6	60.3	28.1	sicl	0.55	0.04	21.87

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.1	15.8	6.6	1.3	0.2	0.2	12.9	52.53	39.15
2	5.0	4.8	1.7	0.5	0.1	0.1	3.8	50.00	38.71
3	4.7	5.5	0.8	0.6	0.3	0.1	5.8	32.73	23.68
4	5.0	9.5	1.4	1.2	0.8	0.1	7.6	36.84	31.53
5	4.6	19.0	4.9	4.4	5.4	0.3	8.0	78.95	65.22

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.86		42.3	38.5			17.4	15.2
2	1.32		35.4	29.5			12.4	11.1
3	1.40		33.7	31.5			10.4	9.5
4	1.52		40.9	38.1			16.5	13.2
5	1.57		47.1	39.8			33.3	25.7

Table 21: SERIES Boswell sl

Location: County Neshoba
Town Bogue Chitto
Region: Upper Coastal Plain
Position: Ridge flat
Elevation: 425'

Aspect: S-35-W
Slope %: 1
Drainage: Moderately well
Parent Material: Wilcox fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 5	55.5	39.5	5.0	sl	2.23	0.86	11.24
2	B_{2t}	5-22	22.5	45.3	32.2	sicl	0.55	0.46	36.16
3	B_{31tg}	22-35	8.3	35.0	56.7	c	0.38	0.41	20.61
4	B_{32tg}	35-55	3.0	52.6	44.4	sic	0.38	0.42	26.51
5	C_{1g}	55-76	4.0	59.0	37.0	sicl	0.32	0.59	28.50

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	18.3	1.2	3.1	0.1	0.3	16.0	25.68	22.71
2	5.3	11.0	3.3	3.1	0.1	0.3	6.1	61.82	52.71
3	5.1	22.3	2.2	6.1	0.2	0.4	15.9	39.91	35.89
4	5.0	24.8	1.3	8.2	0.1	0.4	17.6	40.32	36.23
5	4.8	26.4	1.7	9.6	0.2	0.4	17.6	45.08	40.34

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.24	31.7	27.7	20.3	16.6	13.0	8.5	7.2
2	1.55	37.8	35.2	32.7	30.9	29.6	27.6	25.8
3	1.40	48.7	46.2	43.4	41.9	40.4	39.5	36.7
4	1.41	50.6	47.4	43.9	42.4	41.5	38.0	34.7
5*	1.48		76.2	62.9	51.8	43.8	37.6	26.1

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*Disturbed sample

Table 22: SERIES Boswell sil

Location: County Clarke
Town Goodwater
Region: Lower Coastal Plain
Position: Ridge
Elevation: 310'

Aspect: N-35-E
Slope %: 3
Drainage: Somewhat poorly
Parent Material: Forest Hill fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 5	27.4	51.7	20.9	sil	3.69	0.44	23.92
2	B_{2g}	5-14	15.1	44.9	40.0	sic	2.35	0.12	20.39
3	B_{3g}	14-29	10.3	25.4	64.3	c	1.25	0.03	20.73
4	C_{2g}	29-70	5.6	18.3	76.1	c	0.70	0.13	49.18

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.7	20.4	4.1	2.5	0.1	0.3	14.5	34.31	32.56
2	4.6	28.9	4.3	3.1	0.1	0.3	21.1	26.99	26.99
3	4.4	40.3	5.5	3.8	0.3	0.5	30.5	25.06	24.88
4	3.7	41.5	20.2	8.2	0.2	1.0	19.5	71.33	60.29

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.10	27.6	24.3	19.5	17.2	16.2	14.9	14.3
2	1.25	40.9	37.9	34.3	32.8	30.6	27.2	26.3
3	1.22	56.9	54.9	52.4	49.1	48.4	46.7	40.2
4	1.30	64.2	60.6	53.6	52.6	51.7	48.0	46.1

Table 23: SERIES Boswell sil

Location: County Lawrence Town Monticello	Aspect: N-10-E
Region: Lower Coastal Plain	Slope %: 6
Position: Upper 1/3 slope	Drainage: Moderately well
Elevation: 400'	Parent Material: Hattiesburg fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 7	13.0	74.3	12.7	sil	2.47	0.13	6.57
2	B_2	7-16	3.4	37.5	59.1	c	0.95	0.03	34.04
3	B_{3g}	16-31	2.2	31.6	66.2	c	0.55	0.03	35.24
4	C_{2g}	31-62	8.6	41.8	49.6	sic	0.25	0.03	39.07

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.9	10.9	4.0	1.6	0.1	0.1	7.8	53.21	42.65
2	5.1	39.9	10.2	11.9	0.7	0.7	18.3	58.90	56.22
3	4.9	47.1	11.3	14.8	1.0	0.8	19.9	59.24	58.37

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.35	42.9	38.2	31.1	23.1	22.1	16.4	11.3
2	1.36	51.8	50.0	47.3	41.6	40.7	34.2	30.5
3	1.27	59.7	57.2	50.3	46.9	45.2	42.0	40.0
4	1.50	54.4	52.4	49.9	45.9	41.1	36.9	33.6

Table 24: SERIES Wilcox sil

Location: County Noxubee
Town Mashulaville
Region: Upper Coastal Plain: Interior Flatwoods
Position: Upper 1/3 slope
Elevation: 350'

Aspect: S-25-W
Slope %: 4
Drainage: Somewhat poorly
Parent Material: Porters Creek fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 4	16.5	62.2	21.3	sil	3.13	0.71	23.10
2	B_{21g}	4-12	10.4	43.0	46.6	sic	1.15	0.38	27.17
3	B_{22g}	12-30	5.3	37.0	57.7	c	0.70	0.13	32.89
4	B_{3g}	30-54	5.1	41.7	53.2	sic	0.62	0.27	39.26
5	C_{1g}	54-64	5.6	38.2	56.2	c	0.46	0.14	48.36

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.1	21.8	5.1	3.8	0.1	0.4	12.8	43.12	42.34
2	4.9	24.5	3.5	4.0	0.1	0.4	17.3	32.65	31.62
3	5.0	39.3	3.5	6.9	0.5	0.8	27.8	29.77	29.62
4	5.0	33.5	3.9	9.2	1.3	0.8	23.2	45.37	39.58
5	4.5	35.0	5.1	11.6	1.6	0.9	21.3	54.86	47.41

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.02	36.3	33.0	28.6	26.3	24.9	19.9	18.0
2	1.29	44.6	37.8	32.3	30.7	29.3	27.7	23.5
3	1.32	57.3	53.9	51.5	49.2	48.0	44.2	38.5
4*	1.37	52.2	49.1	46.6	45.0	44.3	37.8	31.2
5	1.42		81.2	70.2	62.5	60.7	49.9	43.6

*Disturbed sample

Table 25: SERIES Wilcox sicl

Location: County Kemper	Aspect: N-15-W
Town Sucarnoochee	Slope %: 1
Region: Upper Coastal Plain: Interior Flatwoods	Drainage: Somewhat poorly
Position: Middle 1/3 slope	Parent Material: Porters Creek fm
Elevation: 200'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 6	13.1	49.5	37.4	sicl	2.23	0.78	43.32
2	B^{p}_{21g}	6-12	8.8	41.4	49.5	sic	0.95	0.28	36.84
3	B_{22g}	12-32	8.8	37.0	54.2	c	0.55	0.41	35.99
4	B_{3g}	32-57	5.0	45.0	50.0	sic	0.62	0.14	39.68
5	IIC	57+	2.7	22.4	74.9	c	0.46	2.45	75.60

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.1	28.3	11.9	7.3	0.6	0.7	15.9	72.44	56.32
2	5.0	31.9	4.7	7.0	0.3	0.6	20.0	39.50	38.65
3	5.0	32.6	4.4	7.0	0.4	0.6	20.4	38.04	37.80
4	4.9	37.3	12.4	11.4	1.3	0.8	17.6	69.44	59.54
5	4.6	51.3	15.0	19.7	2.4	1.5	15.4	75.24	71.48

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.31	45.7	44.2	36.6	34.9	34.3	31.8	27.0
2	1.39	46.0	44.9	42.7	39.6	38.5	36.0	31.8
3	1.40	47.9	46.5	42.8	40.0	38.5	35.9	31.0
4	1.46	55.4	53.3	45.8	44.1	43.3	37.1	33.9
5*	1.51		104.1	92.3	82.8	68.4	65.8	52.5

*Disturbed sample

Table 26: SERIES Wilcox sicl

Location: County Kemper
Town Sucarnoochee
Region: Upper Coastal Plain: Interior Flatwoods
Position: Lower 1/3 slope
Elevation: 225'

Aspect: S-55-E
Slope %: 2
Drainage: Somewhat poorly
Parent Material: Porters Creek fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	19.9	51.2	28.9	sicl	3.69	0.74	25.81
2	B_2	4-17	15.1	45.5	39.4	sicl	1.65	0.39	26.76
3	B_{3g}	17-27	14.0	40.6	45.4	sic	1.25	0.41	30.32
4	C_{1g}	27-56	10.1	34.8	55.1	c	0.70	0.14	43.29
5	IIC	56+	0.9	26.2	72.9	c	0.46	5.94	103.46

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.2	22.5	7.6	4.7	0.1	0.4	13.5	56.89	48.67
2	5.0	21.1	3.5	3.9	0.2	0.4	16.4	37.91	32.79
3	5.0	25.0	2.7	4.7	0.3	0.5	19.4	32.80	29.71
4	5.0	30.5	5.1	8.9	1.5	0.7	18.8	53.11	46.29
5	4.5	42.9	4.8	16.7	3.1	1.9	13.0	61.77	67.09

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.07	35.3	34.2	32.5	31.1	30.1	24.2	18.4
2	1.32	40.3	36.6	34.5	33.2	32.6	30.1	23.3
3	1.38	42.5	42.2	37.6	35.4	35.0	33.6	26.4
4	1.40	50.5	49.9	46.7	44.3	43.2	40.6	32.8
5*	1.50		121.0	107.2	96.0	85.6	71.6	62.1

*Disturbed sample

Table 27: SERIES Wilcox sicl

Location: County Kemper
Town Porterville
Region: Upper Coastal Plain: Interior Flatwoods
Position: Ridge
Elevation: 225'

Aspect: N-10-E
Slope %: 1
Drainage: Somewhat poorly
Parent Material: Porters Creek fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 5	10.8	54.7	34.5	sicl	2.87	0.55	30.44
2	B^p_{2g}	5-23	7.4	52.2	40.4	sic	0.86	0.28	34.26
3	B_{23g}	23-32	8.4	49.2	42.4	sic	0.70	0.30	35.68
4	B_{3g}	32-63	5.5	41.5	53.0	sic	0.46	0.31	50.93
5	IIC	63+	1.6	19.5	78.9	c	0.46	1.48	89.87

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.1	25.8	11.3	6.3	0.2	0.5	13.3	70.93	57.91
2	4.9	23.5	4.1	5.1	0.3	0.5	15.3	42.55	39.53
3	4.9	26.0	3.3	5.5	0.3	0.5	17.4	36.92	35.56
4	4.8	30.8	5.3	9.7	1.5	0.7	17.1	55.84	50.15
5	4.4	43.0	14.7	17.5	2.7	1.5	14.9	84.65	70.96

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.12	45.8	44.5	40.4	37.1	35.0	31.2	23.6
2	1.42	42.7	41.5	36.6	34.6	33.5	32.5	25.7
3	1.50	46.0	43.7	38.3	37.1	36.1	34.1	28.9
4	1.54	53.4	51.4	44.9	42.1	40.8	38.3	31.1
5*	1.50		108.6	96.8	84.9	76.6	70.2	54.4

*Disturbed sample

Table 28: SERIES Susquehanna 1

Location: County Perry	Aspect: East
Town Richton	Slope %: 4
Region: Lower Coastal Plain	Drainage: Somewhat poorly
Position: Ridge	Parent Material: Hattiesburg fm
Elevation: 200'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 4	40.7	40.2	19.1	L	2.60	0.65	21.98
2	B_{2g}	4-12	19.9	34.7	45.4	c	1.15	0.14	46.63
3	B_{3g}	12-26	18.4	41.4	40.2	sic	0.62	0.04	37.10
4	C_{2g}	26-35	17.6	47.5	34.9	sic	0.55	0.15	30.19

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.6	16.4	6.1	4.6	0.1	0.3	7.3	67.68	60.33
2	4.7	32.3	8.3	9.4	0.3	0.7	16.0	57.89	53.89
3	4.8	29.8	7.6	9.8	0.5	0.6	14.5	62.08	56.06
4	4.7	28.5	8.7	10.7	0.9	0.6	11.1	73.33	65.31

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.32	32.1	27.5	21.7	20.4	19.8	17.1	12.7
2	1.41	42.4	40.3	38.5	37.9	36.8	34.4	33.7
3	1.59	50.0	45.8	39.7	35.8	34.9	31.8	31.0
4	1.55	49.3	45.0	40.9	38.5	34.2	30.4	28.6

Order 8. Ultisols

The Ultisols have no natric horizon, but an argillic horizon with a base saturation of less than 35% is present; a fragipan may occur. These soils include what have been classified as the Red-Yellow Podzolic soils, and the Humic and Low-Humic Gley soils. Six families are represented by profiles in this section; sandy, coarse-loamy, and fine,-loamy, siliceous, fine-loamy and fine silty, mixed, and clayey, kaolinitic.

Again there is an appreciable amount of both intra-family and intra-series variation in site index, hardwood problems and regeneration potential.

In general, as the composition of the control section becomes finer, the hardwood control problem becomes more severe because of changes in understory composition, and the regeneration potential becomes more favorable because of greater stored water. The site index, however, increases only until the clayey, kaolinitic soils are reached, and then decreases.

The average site indices for the six families as they are listed above are 69 feet, 91 feet 81 feet, 91 feet, 89 feet, and 78 feet at an age of 50 years.

Table 29: SERIES Eustis cs

Location: County Jasper
Town Garlandville
Region: Upper Coastal Plain
Position: Ridge
Elevation: 600'

Aspect: S-5-E
Slope %: 5
Drainage: Excessivelly well
Parent Material: Cockfield fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 9	92.4	5.1	2.5	cs	1.05	22.15	5.15
2	C_{11}	9-19	93.7	3.8	2.5	cs	0.25	2.90	2.92
3	C_{12}	19-49	96.7	3.1	0.2	cs	0.46	1.09	1.41

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	1.0	0.6	0.1	0.1	0.0	3.1	80.00	20.51
2	5.2	2.0	0.1	0.0	0.0	0.0	0.6	5.00	14.29
3	5.1	3.0	0.9	0.2	0.1	0.1	3.5	43.33	27.08
4									

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1*	1.34		6.9	5.3	3.5	2.9	2.6	2.3
2*	1.43		3.4	2.6	2.3	2.0	1.8	1.4
3*	1.38		2.9	2.1	1.9	1.7	1.5	1.0

*Disturbed sample

Table 30: SERIES Eustis s

Location:	County Clarke Town Quitman	Aspect:	S-45-E
Region:	Upper Coastal Plain	Slope %:	22
Position:	Upper 1/3 slope	Drainage:	Somewhat excessively
Elevation:	260'	Parent Material:	Cockfield fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 8	88.8	11.1	0.1	s	1.15	0.20	1.85
2	A_2	8-34	84.3	15.4	0.3	ls	0.32	0.03	0.92
3	A & B	34-43	87.6	9.9	2.5	s	0.46	0.03	1.73
4	B_2	43-68	81.4	9.6	9.0	ls	0.32	0.03	9.82

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	2.5	0.6	0.1	0.0	0.1	2.6	32.00	23.53
2	5.0	0.5	0.2	0.1	0.0	0.0	0.9	6.00	25.00
3	5.0	0.9	0.2	0.2	0.0	0.0	0.9	4.44	30.77
4	5.0	3.6	1.1	1.1	0.1	0.1	2.1	66.66	53.33

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.02	16.9	11.9	10.6	8.6	6.9	3.5	2.5
2	1.35	17.1	10.4	6.9	4.4	3.9	2.6	1.4
3	1.39	17.1	12.3	8.4	5.3	4.1	2.3	.8
4	1.47	25.8	22.1	19.5	17.4	15.7	13.7	9.9

Table 31: SERIES Eustis cs

Location: County Clarke
Town Pachuta
Region: Upper Coastal Plain
Position: Ridge
Elevation: 360'

Aspect: S-20-E
Slope %: 8
Drainage: Excessively
Parent Material: Cockfield fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 2	88.0	8.7	3.3	cs	2.14	0.65	3.41
2	A_2	2-38	86.0	10.8	3.2	cls	0.25	0.68	0.62
3	A_3	38-54	86.8	7.0	6.2	cls	0.22	0.54	2.79
4	C_2	54+	95.2	1.8	3.0	cs	0.15	0.54	2.00

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.1	3.9	1.4	0.3	0.0	0.1	3.8	46.15	32.14
2	4.9	1.1	0.1	0.0	0.0	0.0	1.1	9.09	8.33
3	4.9	2.1	0.4	0.3	0.0	0.1	1.9	38.10	29.63
4	5.1	0.7	0.3	0.1	0.1	0.0	0.8	71.43	38.46

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.94	13.5	9.0	5.9	4.9	4.6	3.4	2.1
2	1.38	13.4	9.7	6.3	4.6	3.7	2.8	1.9
3	1.37	11.5	9.2	5.5	5.2	5.1	4.1	3.0
4	1.36	7.9	4.9	2.9	2.7	2.3	1.6	1.2

Table 32: SERIES Eustis cls

Location: County Stone Town McHenry	Aspect: N
Region: Lower Coastal Plain	Slope %: 0
Position: ridge flat	Drainage: well
Elevation: 210'	Parent Material: Citronelle fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	81.8	15.2	3.0	cls	1.50	0.79	0.61
2	A_2	4- 9	82.2	14.0	3.8	cls	0.35	0.29	1.17
3	B_t	9-35	78.2	14.2	7.6	cls	0.28	0.31	2.28
4	C_2	35-54	89.0	7.8	3.2	cs	0.28	0.47	1.45

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.0	3.5	0.1	0.1	0.1	0.1	4.5	11.43	8.16
2	5.4	1.4	0.1	0.1	0.1	0.0	2.0	21.43	13.04
3	5.2	0.9	0.2	0.1	0.1	0.0	1.0	44.44	28.57

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.34	21.3	15.8	11.4	10.0	9.4	8.8	4.2
2	1.48	13.6	12.6	8.6	7.3	5.9	4.3	3.0
3	1.55	18.1	14.6	11.2	9.5	9.0	7.3	3.6
4	1.60	15.8	9.3	6.4	4.9	4.0	2.8	1.9

Table 33: SERIES Rumford csl

Location: County Pike
Town Osyka
Region: Lower Coastal Plain
Position: Upper 1/3 slope
Elevation: 350'

Aspect: S-70-W
Slope %: 9
Drainage: Well
Parent Material: Citronelle fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

			Particle size dist.,%				Organic Matter	lbs. per acre inch	
No.	Horizon	Depth, in.	Sand	Silt	Clay	Texture	%	Avail.P	Exch.K
1	A_p	0- 6	66.3	29.2	4.5	csl	1.65	0.55	12.19
2	B_2	6-21	55.8	26.9	17.3	csl	0.46	0.18	18.02
3	B_3	21-39	54.9	29.2	15.9	csl	0.32	0.42	17.99

CHEMICAL DATA

			Exchangeable cations, me./100g.					% Base Saturation	
No.	pH	C.E.C., me./100g.	Ca	Mg	Na	K	H	metals/C.E.C.	metals/cations
1	5.4	4.5	0.8	0.3	0.1	0.1	4.5	28.89	22.41
2	5.2	5.7	0.4	0.9	0.0	0.1	6.6	24.56	17.50
3	5.3	5.5	0.2	0.9	0.0	0.1	6.0	21.82	16.67

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.38	20.8	19.2	14.2	12.7	11.2	8.8	5.6
2	1.56	25.5	24.2	20.3	18.9	16.8	13.8	13.5
3	1.69	28.9	25.6	19.9	17.4	16.6	12.5	10.0

Table 34: SERIES Stough sl

Location: County Noxubee Town Mashulaville	Aspect: S-55-E
	Slope %: 3
Region: Upper Coastal Plain: Interior Flatwoods	Drainage: Somewhat poorly
Position: Ridge flat	Parent Material: Alluvium over Porter's Creek fm
Elevation: 300'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 7	46.0	47.5	6.5	sl	1.15	0.42	10.11
2	B_{2g}	7-21	32.6	49.6	17.8	l	0.46	0.15	7.12
3	B_{3xg}	21-51	30.2	49.2	20.6	l	0.38	0.30	15.35

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.8	5.3	1.9	0.8	0.1	0.1	4.6	54.72	38.67
2	5.1	9.0	1.6	1.2	0.1	0.2	8.1	34.44	27.68
3	4.9	9.5	1.1	1.1	0.1	0.2	9.8	26.22	20.33

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.44	31.7	30.4	19.8	17.6	14.9	13.1	12.2
2	1.31	30.0	28.8	27.3	20.9	17.7	15.4	8.2
3	1.54	42.4	39.8	30.7	26.5	25.7	25.1	11.5

Table 35: SERIES Stough sl

Location: County Noxubee
Town Shuqualak
Region: Upper Coastal Plain: Interior Flatwoods
Position: Ridge flat
Elevation: 300'

Aspect: N-2-E
Slope %: 2
Drainage: Somewhat poorly
Parent Material: Alluvium over Porters Creek fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 5	66.3	31.3	2.4	sl	1.15	0.58	5.48
2	B^{p}_{2g}	5-15	59.3	35.2	5.5	sl	0.32	0.18	4.59
3	B_{3xg}	15-57	50.8	39.5	9.7	l	0.32	0.16	6.52

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	6.1	3.0	0.9	0.3	0.6	0.1	2.6	63.33	42.22
2	5.0	2.5	0.5	0.2	0.1	0.1	2.5	36.00	26.47
3	4.5	3.5	0.1	0.1	0.1	0.1	4.5	11.43	8.16

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.18	19.7	18.4	14.9	10.1	8.6	6.2	5.4
2	1.62	26.2	21.8	18.8	13.7	10.2	7.4	5.1
3	1.60	29.7	24.3	22.1	18.7	14.4	14.2	9.1

Table 36: SERIES Stough sl

Location: County Neshoba	Aspect: S-5-E
Town Bogue Chitto	Slope %: 6
Region: Upper Coastal Plain	Drainage: Somewhat poorly
Position: Upper 1/3	Parent Material: Tuscahoma fm
Elevation: 450'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 3	51.6	43.4	5.0	sl	3.13	0.70	3.74
2	B_{2g}	3-17	40.8	41.6	17.6	l	0.86	0.15	5.24
3	B_{31txg}	17-30	34.1	40.3	25.6	l	0.46	0.15	8.37

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.4	7.6	2.7	0.9	0.1	0.1	7.3	50.00	34.23
2	5.0	6.8	0.7	0.7	0.1	0.1	7.6	23.53	17.39
3	4.9	8.8	0.8	0.9	0.1	0.1	8.3	21.59	18.63

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.18	33.6	30.3	24.3	20.1	16.7	14.6	9.7
2	1.36	29.3	25.8	21.6	20.9	17.4	16.0	14.3
3	1.60	35.8	32.7	29.3	27.5	25.1	21.4	20.1

Table 37: SERIES Stough sl

Location: County Neshoba	Aspect: S-5-E
Town DeWeese	Slope %: 3
Region: Upper Coastal Plain	Drainage: Somewhat poorly
Position: Middle 1/3 flat	Parent Material: Alluvium over Wilcox fm
Elevation: 425'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	44.3	49.4	6.3	sl	4.15	1.23	16.01
2	B_{2g}	4-13	43.3	47.4	9.3	l	0.62	0.74	7.76
3	B_{31xg}	13-25	37.2	46.4	16.4	l	0.62	0.48	12.92
4	B_{32xg}	25-41	39.2	42.6	18.2	l	0.32	0.35	7.97
5	C_{1g}	41-63	43.2	33.3	23.5	l	0.62	0.17	7.70

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.2	10.3	2.5	0.8	0.1	0.2	9.6	34.95	27.27
2	5.1	3.5	0.7	0.3	0.1	0.1	3.4	34.29	26.09
3	5.0	6.0	0.6	0.5	0.0	0.1	5.8	20.00	17.14
4	5.2	6.9	0.1	0.5	0.1	0.1	6.8	11.59	10.53
5	5.3	9.0	0.1	1.4	0.5	0.1	8.9	23.33	19.09

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.24	45.8	48.5	37.8	31.1	28.7	22.1	19.6
2	1.49	30.4	25.3	20.7	15.8	13.8	8.4	6.4
3	1.63	34.1	28.0	25.5	22.4	21.3	16.0	12.5
4	1.76	35.9	29.1	26.8	25.1	23.3	18.5	16.4
5*	1.70		47.4	32.6	30.4	24.8	22.2	17.7

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*Disturbed sample

Table 38: SERIES Cahaba sl

Location: County Clarke Town Quitman	Aspect: N-35-W
Region: Upper Coastal Plain	Slope %: 4
Position: Ridge	Drainage: Well
Elevation: 220'	Parent Material: Cockfield fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0-18	70.1	26.3	3.6	sl	0.70	0.66	2.41
2	B_{21t}	18-38	56.9	20.6	22.5	scl	0.25	0.27	7.45
3	B_{22}	38-60	72.3	17.0	10.7	sl	0.18	0.42	4.60

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.8	2.6	0.1	0.1	0.0	0.0	2.9	7.69	6.45
2	4.8	8.0	0.1	1.0	0.1	0.2	8.4	17.50	14.29
3	4.8	3.7	0.0	0.5	0.1	0.1	4.0	18.92	14.89

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.33	21.8	18.1	14.9	9.3	7.7	6.6	3.5
2	1.37	26.0	23.7	17.9	14.5	14.2	13.4	10.7
3	1.40	20.2	16.4	12.9	11.2	10.8	8.0	7.0

Table 39: SERIES Cahaba sl

Location: County Covington
Town Collins
Region: Lower Coastal Plain
Position: ridge
Elevation: 210'

Aspect: S 80 E
Slope %: 2
Drainage: well
Parent Material: Citronelle fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 8	61.9	35.1	3.0	sl	0.95	3.28	8.73
2	B_{2t}	8-32	35.9	41.6	22.5	l	0.55	0.28	10.62
3	B_{31}	32-65	66.1	26.3	7.6	sl	0.25	0.26	3.95
4	B_{32}	65+				ls			

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.5	3.0	0.9	0.3	0.2	0.2	3.1	53.33	34.04
2	5.4	7.7	3.2	1.0	0.1	0.2	5.5	58.44	45.00
3	5.0	3.1	0.4	0.5	0.1	0.1	3.5	35.48	23.91

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.33	22.9	20.5	13.3	9.7	7.7	6.0	5.0
2	1.40	32.2	30.7	28.6	24.5	20.9	20.6	18.2
3	1.34	26.5	20.0	12.9	10.1	8.6	7.3	4.4

Table 40: SERIES Cahaba sl

Location: County Pike
Town Osyka
Region: Lower Coastal Plain
Position: Upper 1/3 slope
Elevation: 210'

Aspect: N-20-W
Slope %: 3
Drainage: Well
Parent Material: Citronelle fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 4	71.0	23.8	5.2	sl	1.15	0.64	12.81
2	B^{p}_{21t}	4-16	39.2	34.6	26.2	l	0.38	0.16	21.92
3	B_{22}	16-27	57.6	27.8	14.6	sl	0.18	0.17	9.24
4	B_{3}	27-63	75.7	21.0	3.3	ls	0.12	0.51	6.23

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.5	4.5	1.2	0.6	0.0	0.1	3.6	42.22	34.55
2	5.2	9.0	2.4	1.5	0.1	0.2	6.6	46.67	38.89
3	5.4	4.9	1.5	1.1	0.1	0.1	3.4	57.14	45.16
4	5.6	2.0	0.6	0.4	0.1	0.1	1.0	60.00	54.55

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.30	27.1	17.7	13.0	10.7	9.3	8.4	7.4
2	1.64	44.2	33.0	29.1	28.2	27.3	25.4	20.7
3	1.70	28.3	24.9	20.9	20.6	19.7	17.2	13.1
4	1.72	19.6	18.3	15.7	13.1	11.6	10.3	7.2

Table 41: SERIES Ruston ls

Location: County Stone
Town Wiggins
Region: Lower Coastal Plain
Position: Upper 1/3 slope
Elevation: 230'

Aspect: S 60 W
Slope %: 7
Drainage: well
Parent Material: Citronelle fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 5	85.6	11.4	3.0	ls	0.82	0.95	1.09
2	A_2	5-11	77.3	17.2	5.4	ls	0.58	6.55	0.67
3	B_{2t}	11-33	65.7	16.0	18.3	csl	0.35	0.31	3.16
4	B_3	33-58	82.2	12.0	5.8	ls	0.32	0.29	1.01

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	1.9	0.1	0.1	0.1	0.0	3.0	15.79	9.09
2	5.4	1.5	0.1	0.1	0.1	0.0	2.3	20.00	11.54
3	4.9	5.5	0.4	0.2	0.1	0.1	6.3	14.55	11.27
4	5.0	1.6	0.1	0.1	0.1	0.1	2.3	25.00	14.81

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.37	16.7	13.8	7.4	5.5	5.3	4.7	4.5
2	1.47	17.8	15.4	10.0	8.2	6.9	4.4	3.7
3	1.55	23.4	22.3	16.7	16.3	14.7	12.4	11.6
4	1.49	14.5	14.3	7.6	6.9	6.0	4.8	3.9

Table 42: SERIES Ruston ls

Location: County Monroe Town Nettleton	Aspect: S 85 W
Region: Upper Coastal Plain	Slope %: 8
Position: Upper 1/3 Slope	Drainage: well
Elevation: 280'	Parent Material: Eutaw fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist., % Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_2	0-15	75.3	20.7	4.0	ls	0.32	3.14	9.58
2	B_{21t}	15-24	60.4	13.1	26.5	scl	0.18	0.30	104.65
3	B_{22}	24-38	83.8	7.4	8.8	ls	0.07	0.67	57.37
4	B^{I}_{2t}	38-68	78.1	3.6	18.2	sl	0.12	0.29	74.74

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.2	2.3	0.9	0.4	0.0	0.1	1.6	60.87	46.67
2	4.8	11.8	3.8	2.5	0.2	0.9	7.6	62.71	49.33
3	4.8	7.5	2.0	1.4	0.1	0.5	5.8	53.33	40.82
4	4.8	13.8	2.5	4.1	0.1	0.8	8.5	54.35	46.88

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.51	18.6	14.9	10.4	8.9	7.1	5.5	2.3
2	1.54	32.5	31.7	27.6	25.4	25.1	23.3	18.8
3	1.36	18.6	13.3	12.8	11.0	9.2	8.4	8.4
4	1.46	21.1	20.5	16.3	13.2	11.9	10.4	5.9

Table 43: SERIES Ruston sl

Location: County Monroe
Town Quincy
Region: Upper Coastal Plain
Position: Upper 1/3 slope
Elevation: 350'

Aspect: S-55-E
Slope %: 18
Drainage: Well
Parent Material: Eutaw fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 3	65.5	32.2	2.3	sl	3.69	0.89	7.43
2	A_2	3-12	58.8	33.9	7.3	sl	1.05	0.55	7.24
3	B_{2t}	12-40	50.5	19.2	30.3	scl	0.55	0.16	30.76
4	B_{3tg}	40-62	70.4	5.5	24.1	scl	0.38	0.16	16.73
5	C_{2g}	62-72	73.9	5.1	21.0	scl	0.32	0.15	16.31

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	8.3	0.8	0.2	0.1	0.2	8.3	15.66	13.54
2	4.8	2.5	0.2	0.1	0.0	0.1	3.3	16.00	10.81
3	4.9	9.5	0.2	1.6	0.0	0.3	9.8	22.11	17.65
4	4.9	7.5	0.0	0.5	0.0	0.2	7.8	9.33	8.24
5	4.8	7.5	0.1	0.5	0.0	0.1	8.0	9.33	8.05

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.82	26.1	21.8	16.1	11.6	8.9	8.0	5.4
2	1.39	24.1	22.5	15.5	10.3	7.4	6.3	4.4
3	1.57	41.6	37.2	34.7	32.6	31.3	27.2	25.1
4	1.66	31.3	27.6	24.2	22.2	21.8	17.5	16.2

Table 44: SERIES Ruston csl

Location: County Monroe
Town Quincy
Region: Upper Coastal Plain
Position: Ridge
Elevation: 325'

Aspect: S 85 W
Slope %: 5
Drainage: well
Parent Material: Tuscaloosa fm.

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

			Particle size dist.,%				Organic Matter	lbs. per acre inch	
No.	Horizon	Depth, in.	Sand	Silt	Clay	Texture	%	Avail.P	Exch.K
1	A_p	0- 3	64.9	31.7	3.4	csl	1.33	0.78	6.14
2	B_{21t}	3-22	40.6	35.0	24.4	cl	0.25	0.31	21.55
3	B_{22t}	22-34	51.5	23.5	25.0	cscl	0.18	0.49	14.20
4	B_3	34-60	64.3	16.2	19.5	csl	0.07	0.49	13.00

CHEMICAL DATA

			Exchangeable cations, me./100g.					% Base Saturation	
No.	pH	C.E.C., me./100g.	Ca	Mg	Na	K	H	metals/C.E.C.	metals/cations
1	5.0	4.3	1.5	0.5	0.0	0.1	4.0	48.84	34.43
2	5.0	8.3	2.4	1.6	0.1	0.3	6.3	53.01	41.12
3	4.8	7.7	1.1	1.2	0.1	0.2	6.8	33.77	27.66
4	4.8	5.8	0.3	0.7	0.0	0.2	5.5	20.69	17.91

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.13	23.5	20.0	15.7	13.3	11.6	11.1	9.8
2	1.56	30.6	27.9	27.8	26.7	26.5	25.1	22.8
3	1.65	33.5	32.2	26.7	24.3	23.4	22.9	22.4
4	1.64	28.6	25.8	22.5	21.4	19.2	19.0	18.5

Table 45: SERIES Ruston ls

Location: County Attala
Town Kosciusko
Region: Thin Loess
Position: Upper 1/3
Elevation: 480'

Aspect: S 70 E
Slope %: 17
Drainage: well
Parent Material: Kosciusko fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 5	73.4	23.8	2.8	ls	1.03	1.04	1.19
2	A_2	5-13	67.8	28.0	4.2	sl	0.51	0.71	1.62
3	B_{2t}	13-41	55.9	21.6	22.5	scl	0.29	0.31	5.04
4	B_3	41-	66.0	14.9	19.1	sl	0.22	0.30	3.49

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.1	2.6	0.2	0.1	0.1	0.1	3.5	19.23	12.50
2	5.2	1.3	0.1	0.1	0.1	0.1	2.0	30.77	16.67
3	4.8	5.6	0.0	0.9	0.1	0.1	6.5	19.64	14.47

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.31	24.5	19.3	12.3	7.9	6.7	4.8	3.3
2	1.43	21.0	17.4	11.6	9.0	6.7	3.9	2.6
3	1.59	27.8	27.0	25.0	22.4	21.6	19.9	15.6
4	1.54	25.0	21.9	18.0	17.7	17.1	15.2	12.6

Table 46: SERIES Ruston csl

Location: County Lauderdale
Town Meridian
Region: Upper Coastal Plain
Position: Upper 1/3 slope
Elevation: 410'

Aspect: N 85 E
Slope %: 9
Drainage: well
Parent Material: Meridian sand

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 3	67.8	28.4	3.8	csl	1.45	0.93	9.01
2	B_{21t}	3-32	48.6	26.9	24.5	cscl	0.32	0.31	16.64
3	B_{22t}	32-48	59.2	15.2	25.6	cscl	0.18	0.34	7.75

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.2	4.1	1.5	0.5	0.0	0.1	4.4	51.22	32.31
2	4.9	6.6	1.6	1.7	0.1	0.2	7.0	54.55	33.96
3	4.8	5.8	0.2	1.0	0.1	0.1	6.9	24.14	16.87

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.56	22.5	20.7	15.9	12.9	10.8	9.4	5.0
2	1.58	29.9	27.5	24.0	23.7	22.3	20.9	18.6
3	1.71	25.6	24.3	21.4	19.0	18.6	17.1	16.1

Table 47: SERIES Ruston csl

Location:	County	Covington
	Town	Dry Creek
Region:		Lower Coastal Plain
Position:		Upper 1/3 slope
Elevation:		490'

Aspect: N 15 E
Slope %: 11
Drainage: well
Parent Material: Citronelle fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	57.4	35.3	7.3	csl	2.14	1.17	7.22
2	B_{21t}	4-32	35.4	35.6	29.0	cl	0.38	0.97	12.37
3	B_{22t}	32-60	48.0	23.6	28.4	cscl	0.18	0.32	5.57

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	7.8	1.7	0.6	0.0	0.1	7.3	30.77	24.74
2	5.1	8.3	1.1	1.5	0.1	0.2	8.1	34.98	26.36
3	4.6	6.5	0.0	0.9	0.1	0.1	8.6	16.92	11.34

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.18	23.8	22.1	16.6	15.0	13.3	11.9	6.6
2	1.40	28.6	26.0	23.9	21.4	20.9	19.2	16.8
3	1.64	30.2	28.2	24.8	22.3	21.8	18.4	17.2

Table 48: SERIES Ruston csl

Location: County Lincoln	Aspect: N-50-W
Town Ruth	Slope %: 8
Region: Thin Loess	Drainage: Well
Position: Upper 1/3 slope	Parent Material: Citronelle fm
Elevation: 440'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 2	57.8	38.4	3.8	csl	3.13	0.72	9.19
2	A_2	2- 9	47.5	45.0	7.5	csl	0.78	0.41	3.28
3	B_{21t}	9-21	45.2	29.5	25.3	l	0.70	0.03	26.33
4	B_{22}	21-39	56.8	26.9	16.3	csl	0.32	0.04	14.07
5	B^{1}_{2t}	39-73	54.5	24.1	21.4	cscl	0.46	0.04	8.48

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.2	6.4	1.4	0.4	0.2	0.2	7.4	34.38	22.92
2	5.1	3.1	0.5	0.2	0.1	0.1	3.9	29.03	18.75
3	5.0	7.8	0.4	1.7	0.4	0.3	7.8	35.90	26.42
4	5.0	4.8	0.8	0.9	0.1	0.1	5.1	39.58	27.14
5	5.0	5.3	0.8	0.8	0.1	0.1	5.9	33.96	23.38

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1*	1.04		26.0	17.1	12.0	9.1	6.3	4.9
2	1.38	28.6	23.5	18.7	13.5	10.9	5.9	4.5
3	1.49	34.7	31.6	27.8	24.9	24.3	20.6	18.3
4	1.75	29.6	22.5	21.4	19.5	16.8	14.6	14.4
5	1.74	28.6	24.6	23.5	21.4	19.8	18.6	17.5

*Disturbed sample

Table 49: SERIES Ora 1

Location: County Tishomingo
Town Burnsville
Region: Upper Coastal Plain
Position: Middle 1/3 Slope
Elevation: 500'

Aspect: S 75 E
Slope %: 8
Drainage: moderately well
Parent Material: Eutaw fm.

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A&B	0- 4	32.5	46.7	20.8	1	1.25	0.39	16.62
2	B_2	4-13	30.4	44.1	25.5	1	0.55	0.31	18.96
3	B_{3xg}	13-20	36.6	40.1	23.3	1	0.32	0.32	9.78

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.6	8.3	1.2	0.8	0.0	0.2	9.5	26.51	18.80
2	4.6	8.5	0.8	0.9	0.0	0.3	10.0	23.53	16.67
3	4.8	7.0	0.1	0.9	0.0	0.2	8.9	17.14	11.88

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.31	28.6	25.4	21.9	20.0	19.6	18.1	12.2
2	1.55	34.3	31.9	28.5	25.4	24.8	23.7	19.5
3	1.60	32.6	31.2	28.0	24.6	22.6	18.5	12.0

Table 50: SERIES Ora sl, heavy substratum variant

Location: County Kemper Town Pea Ridge	Aspect: S-65-W
Region: Upper Coastal Plain	Slope %: 8
Position: Middle 1/3 slope	Drainage: Moderately well
Elevation: 550'	Parent Material: Colluvium over Wilcox fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0-10	53.9	39.8	6.3	sl	0.86	1.02	7.66
2	B_{2t}	10-24	39.0	32.7	28.3	cl	0.70	0.46	18.14
3	B_{3txg}	24-44	49.7	24.3	26.0	l	0.38	0.48	10.64
4	IIB_{24}	44-55	34.5	25.2	40.3	c	0.55	0.29	14.22
5	$IIIB_3$	55+	17.7	40.8	41.5	sic	0.46	0.59	16.43

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.2	2.3	0.5	0.2	0.0	0.1	3.4	34.78	19.05
2	5.2	8.0	1.8	1.4	0.1	0.2	7.0	43.75	33.33
3	5.1	7.3	0.9	0.9	0.1	0.1	7.5	27.40	21.05
4	4.9	12.5	0.7	1.5	0.1	0.2	12.5	20.00	16.67
5	4.9	16.0	0.7	2.2	0.1	0.2	15.0	20.00	17.58

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.47	29.1	25.6	17.1	13.1	10.6	6.8	4.6
2	1.57	33.9	31.8	28.1	27.2	26.6	23.9	19.1
3	1.62	33.0	30.3	27.1	25.5	24.2	23.2	20.6
4	1.46	43.4	42.3	40.3	38.8	38.2	36.5	33.2
5*	1.48		62.8	52.4	45.2	40.8	35.6	29.5

*Disturbed sample

Table 51: SERIES Ora sl

Location: County Monroe
Town Quincy
Region: Upper Coastal Plain
Position: Lower 1/3 slope
Elevation: 290'

Aspect: S-10-E
Slope %: 12
Drainage: Moderately well
Parent Material: Eutaw fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

		Depth,	Particle size dist.,%				Organic Matter	lbs. per acre inch	
No.	Horizon	in.	Sand	Silt	Clay	Texture	%	Avail.P	Exch.K
1	A_1	0- 2	60.2	35.6	4.2	sl	1.88	1.35	11.24
2	A_2	2- 8	53.5	37.6	8.9	sl	0.70	0.81	13.25
3	B_{21}	8-15	47.6	38.1	14.3	l	0.18	0.93	16.10
4	B_{22g}	15-29	46.3	37.2	16.5	l	0.07	0.96	23.46
5	B_{3xg}	29-60	54.3	24.5	21.2	scl	0.07	0.46	23.20

CHEMICAL DATA

		C.E.C.,	Exchangeable cations, me./100g.					% Base Saturation	
No.	pH	me./100g.	Ca	Mg	Na	K	H	metals/C.E.C.	metals/cations
1	5.2	6.2	1.7	0.7	0.0	0.2	5.4	41.94	32.50
2	5.2	4.4	0.9	0.8	0.0	0.2	4.3	43.18	30.65
3	5.4	4.9	1.2	1.3	0.1	0.3	3.8	59.18	43.28
4	4.9	5.9	0.6	1.5	0.1	0.3	5.1	42.37	32.89
5	4.9	7.9	0.2	2.1	0.1	0.3	8.0	34.18	25.23

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.24	30.6	23.8	22.3	18.8	16.0	15.7	13.9
2	1.36	25.7	23.3	20.1	15.2	15.0	10.6	9.8
3	1.34	24.8	22.2	20.0	16.5	15.4	13.3	10.9
4	1.49	28.8	26.2	23.5	20.0	17.9	17.4	14.9
5	1.54	36.3	30.5	28.3	23.7	23.3	23.0	18.3

Table 52: SERIES Ora sil

Location: County Scott
Town Homewood
Region: Lower Coastal Plain
Position: Middle 1/3 flat
Elevation: 440'

Aspect: N-50-W
Slope %: 4
Drainage: Moderately well
Parent Material: Colluvium over Forest Hill fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 3	42.9	51.8	5.3	sil	2.08	0.48	7.83
2	A_2	3-18	47.6	45.4	7.0	sil	0.62	0.39	5.93
3	B_1	18-24	32.4	50.0	17.6	sil	0.46	0.17	20.52
4	B_{2t}	24-43	23.3	53.9	22.8	sil	0.38	0.17	27.54
5	B_{3xg}	43+	35.1	44.5	20.4	l	0.25	0.16	10.27

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.5	4.8	1.5	0.4	0.1	0.1	5.4	43.75	28.00
2	5.4	2.3	0.6	0.2	0.0	0.1	3.4	39.13	20.93
3	5.2	5.5	1.0	1.0	0.1	0.2	5.4	41.82	29.87
4	5.2	8.9	0.6	2.3	0.1	0.3	8.8	37.08	27.27
5	4.9	7.8	0.7	0.6	0.1	0.1	7.9	19.23	15.96

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.08	23.8	21.2	19.6	12.2	9.9	5.4	4.7
2	1.31	24.9	23.2	18.6	13.0	10.4	6.4	5.0
3	1.51	28.7	26.8	25.1	22.9	19.8	14.2	13.4
4	1.52	34.0	33.0	32.2	28.7	28.2	25.4	20.9
5	1.63	38.6	35.1	31.9	25.9	25.2	21.0	17.4

Table 54: SERIES Ora sil

Location: County Smith
Town Raleigh
Region: Lower Coastal Plain
Position: Lower 1/3 slope
Elevation: 180'

Aspect: S-5-E
Slope %: 2
Drainage: Somewhat poorly
Parent Material: Catahoula fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 6	40.7	54.0	5.3	sil	1.33	0.29	19.56
2	B_{2t}	6-25	27.6	45.6	26.8	l	0.32	0.15	16.15
3	B_{3xg}	25-42	49.5	29.9	20.6	l	0.18	0.14	13.06

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.4	4.5	1.2	2.6	0.2	0.2	7.0	93.33	37.50
2	5.2	12.4	0.3	2.4	0.1	0.1	5.4	23.39	34.94

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.18	30.6	28.5	25.5	20.9	18.2	15.5	9.1
2	1.55	37.1	32.5	30.7	28.6	27.4	26.2	24.0
3	1.62	36.9	34.1	31.0	30.4	28.6	26.8	21.7

Table 54: SERIES Ora sl

Location: County Covington
Town Collins
Region: Lower Coastal Plain
Position: ridge
Elevation: 240'

Aspect: N 30 E
Slope %: 5
Drainage: moderately well
Parent Material: Citronelle fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist., % Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 7	56.2	41.0	2.8	sl	1.88	0.58	7.69
2	A_2	7-12	47.7	44.8	7.5	l	0.62	0.28	6.14
3	B_{2t}	12-25	36.0	38.6	25.4	l	0.35	0.68	13.96
4	B_{3xg}	25-	64.0	25.2	10.8	sl	0.28	0.29	2.94

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.4	3.1	0.3	0.3	0.1	0.1	3.5	25.81	18.60
2	5.2	9.1	0.5	1.0	0.1	0.3	9.8	20.88	16.24
3	5.1	2.8	0.0	0.6	0.1	0.1	3.4	28.57	19.05

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.17	23.8	22.1	15.6	11.4	10.1	9.1	5.7
2	1.39	26.6	25.3	18.2	13.3	13.3	7.3	7.2
3	1.37	34.4	33.4	29.6	23.8	21.8	18.6	18.4
4	1.44	31.8	27.6	24.4	22.0	20.2	16.2	15.0

Table 55: SERIES Ora 1

Location: County Marion Town Hub	Aspect: West
Region: Lower Coastal Plain	Slope %: 0
Position: Ridge flat	Drainage: Moderately well
Elevation: 160'	Parent Material: Alluvium over Hattiesburg fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 7	49.4	43.3	7.3	1	1.55	0.51	6.96
2	B_{2t}	7-20	33.3	43.5	23.2	1	0.62	0.15	13.64
3	B_{3xg}	20-61	49.5	37.7	12.8	1	0.18	0.10	5.54

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	5.1	0.4	0.2	0.0	0.1	6.1	13.73	10.29
2	4.9	8.0	0.1	0.5	0.0	0.1	9.8	8.75	6.67
3	5.1	4.5	0.0	0.3	0.1	0.1	5.4	11.11	8.47

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.28	30.6	24.5	18.8	15.3	12.6	9.2	7.2
2	1.40	29.7	28.7	27.5	25.3	24.9	22.4	19.2
3	1.66	19.9	18.4	15.4	12.9	12.0	10.2	7.7

Table 56: SERIES Savannah sl, heavy substratum variant

Location: County Kemper
Town Pea Ridge
Region: Upper Coastal Plain
Position: Upper 1/3 slope
Elevation: 470'

Aspect: N-2-E
Slope %: 2
Drainage: Moderately well
Parent Material: Alluvium over Tuscahoma fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 5	47.9	45.3	6.8	sl	1.05	1.24	4.56
2	B_{2t}	5-15	33.8	39.6	26.6	l	0.62	0.30	20.52
3	B_{3xg}	15-27	33.5	36.2	30.3	cl	0.38	0.31	3.51
4	IIB_{3g}	27-39	23.4	36.8	39.8	cl	0.32	0.31	4.65

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	3.0	0.4	0.2	0.0	0.1	4.0	23.33	14.89
2	4.8	7.5	2.1	1.1	0.1	0.1	7.0	45.33	32.69
3	4.9	7.5	2.0	1.1	0.1	0.1	7.4	44.00	30.84
4	4.8	10.6	1.6	1.7	0.1	0.1	9.9	33.02	26.12

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.39	28.5	24.9	17.0	14.3	10.3	7.8	4.6
2	1.51	34.6	33.7	37.2	25.4	24.5	23.7	19.8
3	1.55	32.4	31.5	28.4	27.1	26.4	25.6	21.7
4	1.58	67.8	51.8	40.9	35.7	32.5	30.3	23.1

Table 57: SERIES Savannah sl

Location: County Scott
Town Stage
Region: Central Prairie
Position: Upper 1/3 slope
Elevation: 400'

Aspect: S-80-W
Slope %: 4
Drainage: Moderately well
Parent Material: Alluvium over Jackson fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

		Depth,	Particle size dist., %				Organic Matter	lbs. per acre inch	
No.	Horizon	in.	Sand	Silt	Clay	Texture	%	Avail.P	Exch.K
1	A_1	0- 2	52.7	44.8	2.5	sl	2.87	0.59	5.07
2	A_2	2- 9	47.4	47.6	5.0	sl	0.55	0.70	2.87
3	B_{2t}	9-26	30.4	49.4	20.2	l	0.38	0.17	6.93
4	B_{3xgt}	26+	23.0	49.0	28.0	cl	0.32	0.15	23.37

CHEMICAL DATA

		C.E.C.,	Exchangeable cations, me./100g.					% Base Saturation	
No.	pH	me./100g.	Ca	Mg	Na	K	H	metals/C.E.C.	metals/cations
1	5.2	6.9	2.2	0.5	0.0	0.1	6.8	40.58	29.17
2	5.3	2.5	0.6	0.2	0.0	0.0	2.5	3.20	2.42
3	5.0	8.3	1.3	0.6	0.1	0.1	9.0	25.30	18.92
4	5.2	10.6	0.1	2.7	0.1	0.2	9.5	29.25	24.60

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.80	17.9	17.2	14.3	10.4	7.5	7.2	4.7
2	1.41	26.0	22.7	15.8	9.6	8.5	3.9	3.4
3	1.53	32.2	30.5	28.0	26.1	24.2	21.3	17.6
4	1.54	40.7	37.3	35.0	33.9	32.0	29.4	24.8

Table 58: SERIES Savannah 1

Location: County Jasper
Town Rose Hill
Region: Central Prairie
Position: middle 1/3 slope
Elevation: 365'

Aspect: South
Slope %: 2
Drainage: moderately well
Parent Material: alluvium over Jackson fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 5	47.5	43.8	8.7	l	2.47	0.93	5.35
2	B_2	5-19	43.0	43.0	14.0	l	0.50	0.30	2.21
3	B_{3xg}	19-35	55.0	28.8	16.2	sl	0.18	0.62	3.58
4	C_{1g}	35-64	55.9	29.9	14.2	sl	0.28	0.46	2.79

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.1	9.1	2.3	0.6	0.1	0.1	7.6	34.07	28.97
2	4.7	4.9	0.8	0.4	0.0	0.1	5.1	26.53	20.31
3	4.6	5.1	0.7	0.7	0.1	0.1	4.4	31.37	26.67
4	4.8	5.3	0.7	0.7	0.1	0.1	5.0	30.19	24.24

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.35	34.2	32.3	28.1	24.5	21.6	18.8	12.8
2	1.50	27.6	24.8	19.4	15.9	15.2	13.1	8.4
3	1.58	30.0	21.8	21.2	16.1	15.6	13.3	10.1
4	1.54	44.9	27.4	19.1	15.4	12.2	10.1	8.5

Table 59: SERIES Savannah sl

Location: County Smith
Town Raleigh
Region: Lower Coastal Plain
Position: Upper 1/3 slope
Elevation: 470'

Aspect: S-5-E
Slope %: 7
Drainage: Moderately well
Parent Material: Catahoula fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 3	55.0	40.2	4.8	sl	2.08	0.61	10.59
2	A_2	3-12	46.2	47.9	5.9	sl	0.46	0.40	6.83
3	B_{2t}	12-22	35.8	35.7	28.5	cl	0.38	0.17	17.10
4	B_{3xg}	22-40	55.4	22.2	22.4	scl	0.32	0.16	10.27

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.4	5.1	0.9	0.3	0.0	0.1	5.3	25.49	19.70
2	5.1	2.4	0.2	0.2	0.1	0.1	2.8	25.00	17.65
3	5.1	9.1	0.4	3.1	0.1	0.2	8.3	41.76	31.40
4	5.2	5.9	0.0	2.3	0.1	0.1	4.4	42.37	36.23

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.23	33.9	20.4	19.2	12.8	11.9	6.5	6.2
2	1.34	26.6	20.6	18.8	16.8	10.5	8.8	4.2
3	1.48	34.3	30.3	29.8	28.9	27.0	25.6	21.0
4	1.62	27.9	27.4	25.5	24.8	22.2	18.1	16.3

Table 60: SERIES Savannah sl, heavy substratum variant

Location: County Greene Town Leakesville	Aspect: S 70 W
	Slope %: 4
Region: Lower Coastal Plain	Drainage: moderately well
Position: middle 1/3 slope	Parent Material: Colluvium over Hattiesburg fm
Elevation: 200'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 5	59.5	27.5	13.0	sl	1.45	0.68	2.81
2	B_2	5-20	56.8	23.7	19.5	sl	0.51	0.31	1.77
3	B_{3xg}	20-33	53.8	26.4	19.8	sl	0.15	0.32	1.45
4	IIC_{1g}	33-37	27.8	35.3	36.9	cl	0.22	0.32	7.97

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	5.9	0.4	0.4	0.1	0.1	7.5	16.95	11.76
2	4.9	5.0	0.4	0.3	0.1	0.1	6.9	18.00	11.54
3	4.7	5.1	0.3	0.3	0.6	0.4	6.4	31.37	20.00
4	4.9	11.9	0.5	1.0	0.2	0.2	11.5	15.97	14.18

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.38	36.7	29.5	18.5	14.4	11.8	9.7	6.0
2	1.56	34.2	30.7	24.6	20.9	17.6	14.4	11.4
3	1.60	32.8	31.5	27.5	22.1	17.9	16.3	12.0

Table 61: SERIES Savannah csl

Location: County Pike
Town Osyka
Region: Lower Coastal Plain
Position: Lower 1/3 slope
Elevation: 300'

Aspect: S-70-W
Slope %: 16
Drainage: Moderately well
Parent Material: Citronelle fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	60.8	35.3	3.9	csl	2.87	1.11	12.94
2	B_2	4-18	45.7	39.8	14.9	l	0.55	0.60	17.74
3	B_{3xg}	18-67	52.0	31.9	16.1	csl	0.25	0.56	15.96

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	6.6	1.3	0.6	0.0	0.2	6.8	31.82	23.60
2	5.3	4.0	0.6	0.4	0.0	0.1	4.3	27.50	20.37
3	5.0	3.8	0.2	0.5	0.1	0.1	4.3	23.68	17.31

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.02	22.4	19.2	17.6	14.2	13.2	12.6	10.7
2	1.35	24.4	21.6	18.7	17.0	14.5	10.3	8.8
3	1.62	28.9	23.9	19.9	17.4	16.2	12.5	10.0

Table 62: SERIES Mashulaville sl

Location: County Jasper
Town Rose Hill
Region: Central Prairie
Position: Middle 1/3 flat
Elevation: 370'

Aspect: S-50-W
Slope %: 1
Drainage: Somewhat poorly - poorly
Parent Material: Alluvium over Jackson fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 3	54.2	40.4	5.4	sl	1.88	0.57	5.22
2	B_{2g}	3-15	51.6	40.4	8.0	l	0.55	0.29	3.02
3	B_{3xg}	15-38	48.7	38.7	12.6	l	0.38	0.19	3.38

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.2	4.3	0.9	0.3	0.0	0.1	5.0	30.23	20.63
2	5.0	3.0	0.5	0.2	0.0	0.0	3.3	2.33	1.75
3	4.8	3.6	0.3	0.2	0.1	0.1	4.3	1.94	1.40

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.28	26.6	23.4	22.1	16.5	14.6	8.6	6.9
2	1.48	24.0	21.9	19.1	15.0	13.9	8.6	5.8
3	1.66	26.4	23.9	21.7	17.4	16.2	11.5	9.2

Table 63: SERIES Mashulaville sil, c. loamy variant

Location: County Oktibbeha Town State College	Aspect: South
Region: Upper Coastal Plain: Interior Flatwoods	Slope %: 0
Position: Lower 1/3 flat	Drainage: Poorly
Elevation: 300'	Parent Material: Alluvium over Porters Creek fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	30.7	58.2	11.1	sil	2.35	0.83	10.19
2	B_{2g}	4-12	28.3	58.3	13.4	sil	0.55	0.30	5.81
3	B_{31xg}	12-28	26.9	57.2	15.9	sil	0.70	0.16	7.07
4	B_{32xg}	28-47	28.1	54.0	17.9	sil	0.38	0.16	7.34
5	C_{2g}	47-58	26.7	47.0	26.3	l	0.32	0.17	14.27

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	6.0	1.1	0.5	0.1	0.1	7.8	30.00	18.75
2	4.9	5.3	0.8	0.4	0.1	0.1	24.1	26.42	54.90
3	4.8	6.5	0.4	0.4	0.1	0.1	21.3	15.38	44.84
4	5.2	7.3	0.7	0.5	0.2	0.1	8.0	20.55	15.79
5	5.1	14.0	0.8	2.0	0.7	0.2	12.4	26.43	22.98

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.20	41.2	33.5	26.3	23.7	20.2	16.3	9.1
2	1.51	39.1	34.2	28.6	25.1	21.4	13.9	8.7
3	1.56	38.3	33.5	30.4	27.8	24.0	15.7	10.9
4	1.62	39.6	35.0	31.1	28.3	26.4	22.1	13.4
5	1.68	39.3	36.8	35.6	32.4	30.5	26.4	22.5

Table 64: SERIES Mashulaville sil, c. loamy variant

Location: County Neshoba
Town Deweese
Region: Upper Coastal Plain
Position: Lower 1/3 flat
Elevation: 425'

Aspect: S-5-E
Slope %: 2
Drainage: Poorly
Parent Material: Alluvium over Wilcox fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_g	0- 3	36.3	59.7	4.0	sil	3.62	1.02	5.84
2	B_g	3-24	55.1	40.4	4.5	sl	0.46	0.48	1.68
3	C_{xg}	24-49	49.4	38.0	12.6	l	0.32	0.34	6.58

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.6	7.4	0.5	0.3	0.1	0.1	8.9	13.51	10.10
2	4.9	1.8	0.2	0.1	0.1	0.0	2.0	22.22	16.67
3	5.1	5.8	0.1	0.4	0.1	0.1	5.9	12.07	10.60

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.29	37.7	36.5	33.6	32.0	30.3	20.3	14.8
2	1.65	28.2	25.6	18.2	12.9	10.8	6.0	3.0
3	1.71	32.0	26.8	24.4	22.8	19.9	18.3	13.3

Table 65: SERIES Mashulaville sil, c. loamy variant

Location: County Scott Town Forest	Aspect: S-35-W
	Slope %: 2
Region: Central Prairie	Drainage: Poorly drained
Position: Ridge flat (Terrace)	Parent Material: Alluvium over Jackson fm
Elevation: 450'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

		Depth,	Particle size dist.,%				Organic Matter	lbs. per acre inch	
No.	Horizon	in.	Sand	Silt	Clay	Texture	%	Avail.P	Exch.K
1	A_1	0- 3	42.8	50.9	6.3	sil	2.35	1.78	8.15
2	A_{2g}	3-10	48.9	46.1	5.0	csl	0.70	0.16	3.32
3	B_{2xg}	10-44	42.2	47.7	10.1	l	0.46	0.04	3.28
4	C_g	44-63	34.5	40.1	25.4	l	0.38	0.04	12.76

CHEMICAL DATA

		C.E.C.,	Exchangeable cations, me./100g.					% Base Saturation	
No.	pH	me./100g.	Ca	Mg	Na	K	H	metals/C.E.C.	metals/cations
1	5.3	5.8	1.3	0.5	0.1	0.1	5.3	34.48	27.40
2	5.2	2.5	0.7	0.2	0.1	0.0	2.5	40.00	28.57
3	4.9	5.3	1.2	0.3	0.1	0.1	5.0	32.08	25.37
4	5.2	11.8	2.3	1.2	0.5	0.2	10.0	35.59	29.58

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.24	39.1	30.2	24.8	17.7	15.4	9.1	6.1
2	1.63	28.7	24.8	21.3	8.8	7.3	5.7	4.1
3	1.61	31.1	28.5	27.3	17.2	14.5	10.5	8.7
4*	1.61		48.0	34.2	29.8	27.4	21.6	16.4

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*Disturbed sample

Table 66: SERIES Mashulaville sl , c . loamy variant

Location: County Scott
Town Pulaski
Region: Lower Coastal Plain
Position: Lower 1/3 slope
Elevation: 450'

Aspect: N-75-E
Slope %: 2
Drainage: Poorly drained
Parent Material: Forest Hill fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A&B	0- 8	46.3	47.4	6.3	sl	0.86	1.12	6.20
2	B_{31g}	8-18	39.2	52.0	8.8	sil	0.46	1.28	3.30
3	B_{32xtg}	18-26	27.1	47.7	25.2	l	0.46	0.82	15.04
4	C_{2g}	26-47	26.6	50.5	22.9	sil	0.32	0.67	15.31

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	4.0	0.4	0.1	0.1	0.0	4.3	15.00	12.24
2	4.7	12.8	1.3	1.0	0.5	0.2	12.0	23.44	20.00
3	4.8	13.0	4.1	2.5	0.9	0.2	7.8	59.23	49.68
4	5.3	3.5	1.8	0.4	0.0	0.1	2.5	65.71	47.92

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.61	28.2	23.8	17.5	11.6	9.2	5.9	4.3
2	1.62	36.2	29.4	27.1	18.2	12.3	10.4	6.9
3	1.66	37.4	31.3	30.1	28.5	26.5	22.4	17.0
4	1.69	36.2	33.6	28.3	25.5	23.7	20.2	17.9

Table 67: SERIES Myatt sicl

Location: County Tishomingo
Town Belmont
Region: Upper Coastal Plain
Position: Terrace
Elevation: 460'

Aspect: N-80-E
Slope %: 3
Drainage: Poorly
Parent Material: Recent alluvium

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_{1g}	0- 3	8.2	63.4	28.4	sicl	5.56	1.51	42.93
2	B_{2g}	3-12	8.0	68.8	23.2	sil	1.33	0.44	40.27
3	B_{3g}	12-25	9.3	60.5	30.2	sicl	0.55	0.44	14.58
4	C_{1g}	25-63	13.8	64.1	22.1	sil	0.55	0.14	9.13

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.7	27.8	11.1	3.6	0.3	0.8	18.1	56.83	46.61
2	5.3	10.3	2.3	1.2	0.1	0.5	8.6	39.81	32.28
3	4.8	10.3	1.1	1.0	0.1	0.2	10.4	23.30	18.75
4	5.1	8.5	0.8	0.9	0.2	0.1	8.5	23.53	19.05

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.07	64.6	63.3	57.2	52.1	47.7	44.7	35.1
2	1.27	35.5	35.0	30.9	28.4	25.7	22.7	17.1
3	1.48	40.3	37.6	35.4	31.3	27.1	25.3	20.2
4	1.44	34.9	34.5	33.5	29.4	26.7	22.0	19.2

Table 68: SERIES Myatt sl

Location: County Tishomingo Town Iuka	Aspect: East
Region: Upper Coastal Plain	Slope %: 2
Position: Terrace	Drainage: poorly
Elevation: 440'	Parent Material: recent Alluvium

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_{1g}	0- 5	70.1	26.2	3.7	sl	1.05	0.98	9.33
2	B_{2g}	5-13	63.2	29.8	7.0	sl	0.38	0.44	2.18
3	C_{xg}	13+	54.9	31.4	13.7	sl	0.32	0.30	3.42

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.7	3.1	0.4	0.3	0.1	0.1	3.8	29.03	19.15
2	4.6	2.8	0.1	0.2	0.1	0.1	3.8	17.86	11.63
3	4.6	6.3	0.4	0.5	0.1	0.1	6.6	17.46	14.29

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.42	22.7	20.0	14.3	10.6	9.9	8.5	4.1
2	1.48	26.0	22.5	13.9	12.1	11.0	8.9	6.2
3	1.51	36.3	28.7	23.6	17.9	16.0	12.8	9.7

Table 69: SERIES Myatt sl

Location: County Monroe
Town Becker
Region: Upper Coastal Plain
Position: Terrace
Elevation: 220'

Aspect: West
Slope %: 1
Drainage: Poorly
Parent Material: Recent Alluvium

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_{1g}	0- 4	66.4	28.8	4.8	sl	3.54	1.69	1.25
2	B_{2g}	4-13	59.8	30.3	9.9	sl	0.62	0.60	0.61
3	B_{3g}	13-42	56.2	30.7	13.1	sl	0.25	0.43	0.66

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.2	8.3	0.1	0.1	0.1	0.0	10.4	3.61	2.80
2	4.5	3.8	0.0	0.0	0.0	0.0	5.3	0.00	0.00
3	4.6	5.0	0.1	0.2	0.1	0.1	6.5	10.00	7.14

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.10	25.8	24.5	14.7	14.1	12.9	11.0	8.2
2	1.35	25.6	21.1	15.3	10.9	8.9	8.4	6.6
3	1.45	45.7	28.0	19.7	15.7	12.9	11.6	7.7

Table 70: SERIES Myatt sil

Location: County Monroe
Town Smithville
Region: Upper Coastal Plain
Position: Terrace
Elevation: 260'

Aspect: East
Slope %: 0
Drainage: Poorly
Parent Material: Recent Alluvium

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 2	31.4	56.1	12.5	sil	2.00	1.79	55.24
2	B_{2g}	2-11	30.4	57.2	12.4	sil	1.00	1.10	24.33
3	B_{3xg}	11-31	32.8	54.8	12.4	sil	0.55	0.78	18.27

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
2	5.6	8.1	2.1	0.9	0.1	0.4	8.8	43.21	28.46
3	5.2	6.1	0.7	0.3	0.1	0.2	7.4	21.31	14.94

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.34	36.0	31.7	27.3	21.6	18.6	18.0	12.1
2	1.40	36.3	33.1	26.4	20.7	17.6	16.0	11.0
3	1.44	36.6	34.5	25.6	19.7	16.7	14.0	9.9

Table 71: SERIES Myatt sl

Location: County Smith
Town Lingle
Region: Lower Coastal Plain
Position: Terrace
Elevation: 360'

Aspect: West
Slope %: 1
Drainage: Poorly
Parent Material: Recent Alluvium

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_{1g}	0- 3	52.4	45.0	2.6	sl	2.87	0.58	8.97
2	B_{2g}	3- 8	48.7	46.3	5.0	sl	0.62	0.16	13.64
3	B_{3xg}	8-36	34.4	50.5	15.1	sil	0.32	0.17	5.93
4	C_{1g}	36-48	28.6	60.4	11.0	sil	0.38	0.14	7.94

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.0	8.0	0.7	0.7	0.2	0.1	6.0	21.25	22.08
2	5.6	3.5	1.4	0.3	0.1	0.0	2.6	51.43	40.91
3	5.2	6.5	1.6	0.5	0.1	0.1	5.3	35.38	30.26
4	5.0	6.8	1.8	1.1	0.1	0.1	5.0	45.59	38.27

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.90	26.3	23.4	22.8	20.6	17.0	15.3	10.1
2	1.40	27.8	25.4	19.1	13.4	10.6	4.9	3.2
3	1.54	34.7	31.2	27.9	24.1	23.5	20.8	16.8
4	1.46	27.5	25.9	22.9	22.0	18.1	15.3	8.6

Table 72: SERIES Myatt sil

Location: County Greene
Town Leakesville
Region: Lower Coastal Plain
Position: Terrace
Elevation: 140'

Aspect: West
Slope %: 0
Drainage: Poorly
Parent Material: Recent Alluvium

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_{1g}	0- 6	26.5	58.2	15.3	sil	4.14	2.20	5.18
2	B_g	6-20	25.2	65.7	9.1	sil	0.62	0.43	2.12
3	C_{1g}	20-26	14.4	59.6	26.0	sil	0.28	0.28	4.79

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
2	4.5	4.6	0.2	0.1	0.1	0.0	5.9	8.70	6.35
3	4.7	11.5	0.2	0.5	0.2	0.1	13.5	8.70	6.90

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.27	51.6	51.1	45.1	31.9	25.4	20.8	21.2
2	1.44	38.9	36.6	28.8	18.2	15.6	10.9	7.9
3	1.41	40.0	36.0	29.1	24.0	22.4	20.8	15.8

Table 73: SERIES Myatt sil

Location: County Forrest
Town Hattiesburg
Region: Lower Coastal Plain
Position: terrace
Elevation: 180'

Aspect: S 70 E
Slope %: 2
Drainage: poorly
Parent Material: recent alluvium

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 3	28.9	61.6	9.5	sil	3.27	0.55	13.32
2	B_{2g}	3-12	28.0	61.3	10.7	sil	1.50	0.40	10.74
3	C_{2g}	12-35	27.6	57.4	15.0	sil	0.50	0.27	8.69
4	C_{3g}	35+				sil			

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.4	9.3	2.1	1.2	0.1	0.2	9.3	38.71	27.91
2	5.2	7.6	0.4	0.7	0.1	0.2	6.8	18.42	17.07

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.12	51.9	39.8	35.7	29.6	29.3	28.7	27.8
2	1.20	39.8	28.8	26.9	21.6	18.4	15.7	10.0
3	1.37	42.3	34.4	28.4	24.4	22.1	16.0	14.4

Table 74: SERIES Myatt sl

Location: County Forrest
Town McCallum
Region: Lower Coastal Plain
Position: Terrace
Elevation: 140'

Aspect: East
Slope %: 1
Drainage: Poorly
Parent Material: Recent Alluvium

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_{1g}	0- 5	53.4	41.9	4.7	sl	3.00	1.04	5.28
2	B_{2g}	5-10	49.3	46.8	3.9	sl	0.46	0.17	1.72
3	B_{3g}	10-35	48.6	36.9	14.5	l	0.38	0.19	3.36
4	C_{1g}	35-58	53.4	35.8	10.8	sl	0.25	0.21	9.07

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.7	6.7	0.5	0.2	0.2	0.1	8.3	14.93	10.75
2	4.8	1.5	0.0	0.0	0.1	0.0	2.3	6.67	4.17
3	4.5	6.5	0.0	0.1	0.3	0.0	7.8	6.15	4.88

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.06	30.6	23.4	22.8	20.6	17.0	15.3	10.1
2	1.52	27.8	25.4	19.1	13.4	10.6	4.9	3.2
3	1.65	34.7	31.2	27.9	24.1	23.5	20.8	16.8
4	1.62	27.5	25.9	22.9	22.0	18.1	15.3	8.6

Table 75: SERIES Pheba sil

Location: County Tishomingo
Town Golden
Region: Upper Coastal Plain
Position: Ridge flat
Elevation: 470'

Aspect: S-15-E
Slope %: 1
Drainage: Somewhat poorly
Parent Material: Alluvium over Tuscaloosa fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	23.1	68.6	8.3	sil	5.56	0.75	8.34
2	B_{2g}	4-11	17.3	66.1	16.6	sil	0.86	0.12	5.75
3	B_{3xg}	11-20	19.4	60.6	20.0	sil	0.62	0.26	5.84
4	C_{2g}	20-43	19.0	60.1	20.9	sil	0.55	0.41	8.75

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.8	16.5	1.0	0.6	0.1	0.3	16.6	12.12	10.75
2	4.8	7.0	0.2	0.3	0.1	0.1	8.0	10.00	8.05
3	4.7	7.0	0.2	0.4	0.1	0.1	8.5	11.43	8.60
4	5.0	7.6	0.2	0.5	0.1	0.1	8.6	11.84	9.47

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.80	36.9	35.1	29.2	22.4	19.9	17.5	10.6
2	1.27	38.1	35.2	29.2	25.8	21.2	17.5	11.4
3	1.29	33.7	31.0	28.2	25.5	22.5	17.3	12.8
4	1.38	34.1	31.1	29.7	27.0	25.4	21.0	14.5

Table 76: SERIES Pheba sil

Location: County Itawamba
Town Mantachie
Region: Upper Coastal Plain
Position: Lower 1/3 flat
Elevation: 365'

Aspect: East
Slope %: 1
Drainage: Somewhat poorly
Parent Material: Alluvium over Eutaw fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	29.2	63.7	7.1	sil	3.77	0.84	9.36
2	B_{2g}	4-12	19.3	58.1	22.6	sil	0.86	0.12	4.82
3	B_{31xg}	12-18	18.2	57.2	24.6	sil	0.70	0.13	7.28
4	B_{32xg}	18-50	22.4	57.1	20.5	sil	0.46	0.03	5.77

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	8.5	1.8	0.7	0.0	0.2	7.9	31.76	25.47
2	4.6	10.5	0.8	0.7	0.1	0.1	10.4	16.19	14.05
3	4.7	11.5	0.8	0.9	0.1	0.1	10.9	16.52	14.84
4	4.9	10.6	0.3	0.7	0.1	0.1	10.5	11.32	10.26

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.06	35.8	33.2	26.9	19.5	18.2	17.7	15.7
2	1.33	36.9	32.4	28.0	22.4	19.9	16.3	15.8
3	1.34	41.2	34.4	30.2	25.9	23.9	22.0	20.3
4	1.34	38.2	31.9	28.8	25.6	23.5	17.6	16.9

Table 77: SERIES Pheba sil

Location: County Oktibbeha
Town Sturgis
Region: Upper Coastal Plain
Position: Lower 1/3 flat
Elevation: 340'

Aspect: West
Slope %: 1
Drainage: Somewhat poorly
Parent Material: Alluvium over Porter's Creek fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 5	42.5	52.7	4.8	sil	1.98	0.88	8.48
2	B_{2g}	5-12	38.4	55.3	6.3	sil	0.86	0.57	7.61
3	B_{3xg}	12-38	33.6	53.6	12.8	sil	0.38	0.22	6.03

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.6	5.4	0.7	0.2	0.0	0.1	6.8	18.52	12.82
2	4.8	3.5	0.4	0.2	0.0	0.1	4.5	20.00	13.46
3	5.0	4.3	0.4	0.4	0.1	0.1	5.1	23.26	16.39

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.04	26.1	24.7	17.2	10.7	9.5	8.7	6.0
2	1.43	41.0	28.0	21.2	14.1	12.6	11.6	9.1
3	1.48	43.5	32.4	24.1	17.7	15.7	14.7	8.7

Table 78: SERIES Pheba sil

Location: County Oktibbeha
Town State College
Region: Upper Coastal Plain: Interior Flatwoods
Position: Ridge flat
Elevation: 200'

Aspect: N-20-W
Slope %: 2
Drainage: Somewhat poorly
Parent Material: Alluvium over
Porter's Creek fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 3	12.6	72.6	14.8	sil	3.27	0.27	16.82
2	B_{2g}^{p}	3-11	8.4	69.8	21.8	sil	1.05	0.18	15.17
3	B_{3xg}	11-24	10.0	69.0	21.0	sil	0.55	0.28	17.39
4	C_{1g}	24-48	9.0	63.0	28.0	sicl	0.38	0.21	19.11

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	14.8	4.8	2.3	0.1	0.2	11.8	50.00	38.54
2	4.9	12.9	2.3	1.8	0.1	0.2	10.3	34.11	29.93
3	4.9	12.9	1.2	2.0	0.1	0.2	12.4	27.13	22.01
4	5.2	14.5	1.1	2.4	0.3	0.2	13.5	27.59	22.86

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.10	44.7	41.8	38.9	36.1	34.8	32.3	19.0
2	1.24	38.3	34.7	31.7	26.0	24.4	22.1	16.4
3	1.42	40.4	37.6	34.2	30.9	28.9	27.5	19.5
4	1.43	40.4	37.3	34.3	31.5	30.3	29.6	22.1

Table 79: SERIES Pheba sil

Location: County Rankin
Town Rock Hill
Region: Lower Coastal Plain
Position: Middle 1/3 flat
Elevation: 410'

Aspect: S-20-E
Slope %: 1
Drainage: Somewhat poorly
Parent Material: Catahoula fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 6	15.7	72.0	12.3	sil	2.47	0.27	6.97
2	B^{p}_{2g}	6-21	37.7	49.7	12.6	l	0.46	0.15	6.70
3	B_{3xg}	21-38	32.8	49.2	18.0	l	0.32	0.02	12.23

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	8.8	3.1	1.0	0.1	0.1	8.0	48.86	34.96
2	5.2	5.5	2.2	0.8	0.1	0.1	4.3	58.18	42.67
3	5.0	8.8	1.5	1.3	0.2	0.1	7.3	35.23	29.81

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.10	36.8	35.7	34.8	23.2	20.5	19.8	10.0
2	1.48	36.7	32.8	28.8	19.7	17.0	12.2	9.5
3	1.50	39.8	35.9	33.0	23.8	22.1	20.4	15.6

Table 80: SERIES Pheba sil

Location: County Rankin
Town Thomasville
Region: Lower Coastal Plain
Position: Ridge flat
Elevation: 360'

Aspect: N-5-E
Slope %: 2
Drainage: Somewhat poorly
Parent Material: Loess or Alluvium over Catahoula fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 3	11.9	72.6	15.5	sil	3.41	0.27	8.81
2	B_{2g}	3- 9	11.8	75.0	13.2	sil	0.70	0.19	5.84
3	B_{3xg}	9-32	9.0	79.9	11.1	sil	0.25	0.21	5.11

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.1	13.3	3.9	1.9	0.1	0.2	9.8	45.86	38.36
2	5.2	8.4	2.4	1.1	0.1	0.1	7.8	44.05	32.17
3	5.4	5.9	0.4	0.3	0.3	0.1	6.8	18.64	13.92

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.08	37.9	35.9	35.6	29.2	26.9	26.4	15.9
2	1.29	40.7	39.5	35.8	28.1	22.9	21.0	13.4
3	1.35	42.5	41.2	36.2	28.1	22.3	18.7	12.0
4	1.41	44.4	42.9	36.6	28.2	21.7	16.3	10.6

Table 81: SERIES Pheba sil

Location: County Smith
Town Trenton
Region: Lower Coastal Plain
Position: Ridge flat
Elevation: 450'

Aspect: East
Slope %: 0
Drainage: Somewhat poorly
Parent Material: Alluvium over Vicksburg fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 2	19.4	72.9	7.7	sil	2.35	0.36	10.40
2	B_{2g}	2- 8	16.3	72.5	11.2	sil	0.78	0.69	10.70
3	B_{3xg}	8-28	11.6	68.2	20.2	sil	0.55	0.15	10.09

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.4	6.5	2.0		0.1	0.2	5.8	35.38	28.40
2	5.2	5.9	1.6	0.5	0.1	0.1	5.0	38.98	31.51
3	4.9	5.1	0.8	0.5	0.1	0.1	8.6	29.41	14.85

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.82	28.6	22.7	21.0	18.4	16.4	15.7	8.5
2	1.39	33.1	26.5	25.6	17.9	14.3	13.6	8.3
3	1.31	33.3	31.0	26.9	21.8	20.3	18.5	13.1

Table 82: SERIES Pheba sil

Location: County Smith
Town Lingle
Region: Lower Coastal Plain
Position: Ridge flat
Elevation: 365'

Aspect: S-65-E
Slope %: 2
Drainage: Somewhat poorly
Parent Material: Alluvium over Forest Hill fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	42.4	52.4	5.2	sil	1.88	0.58	8.97
2	B_{2g}	4- 8	31.6	54.3	14.1	sil	0.62	0.16	13.64
3	B_{31xg}	8-19	25.4	56.6	18.0	sil	0.38	0.17	5.93
4	B_{32xg}	19+	28.6	60.4	11.0	sil	0.25	0.15	8.37

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.6	5.9	1.7	0.5	0.1	0.1	5.3	40.68	31.17
2	5.6	5.5	2.2	0.6	0.1	0.1	4.3	54.55	41.10
3	5.4	6.8	0.5	0.8	0.1	0.1	5.4	22.06	21.74

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.14	27.9	23.9	22.1	17.6	13.4	12.4	9.2
2	1.48	31.5	28.0	26.7	19.6	17.3	13.6	9.9
3	1.42	32.0	30.5	27.3	22.2	20.1	14.9	12.7
4	1.54	38.3	32.2	30.8	26.5	22.9	19.1	13.2

Table 83: SERIES Luverne ls

Location: County Monroe
Town Quincy
Region: Upper Coastal Plain
Position: Upper 1/3 slope
Elevation: 350'

Aspect: S-45-W
Slope %: 14
Drainage: Well
Parent Material: Tuscaloosa or Eutaw fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 4	76.8	18.3	4.9	ls	0.95	0.50	4.82
2	A_2	4-10	83.1	12.5	4.4	ls	0.32	0.15	3.62
3	B_{2t}	10-30	54.4	7.7	37.9	sc	0.78	0.16	14.15
4	B_3	30+	70.2	10.0	19.8	sl	0.38	0.16	6.28

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.0	3.6	0.2	0.1	0.0	0.1	4.1	1.11	0.89
2	5.2	1.6	0.2	0.1	0.0	0.0	1.6	1.88	1.58
3	5.0	12.0	0.3	2.5	0.1	0.2	13.6	25.83	18.56
4	5.3	6.5	0.2	0.9	0.1	0.1	6.6	20.00	16.46

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.12	14.5	13.1	10.6	8.9	8.2	5.6	3.7
2	1.33	14.3	12.5	7.8	6.6	6.0	3.7	3.0
3	1.42	37.9	35.6	34.9	34.1	32.3	30.0	27.4
4	1.46	27.3	26.3	24.4	21.4	20.4	20.1	19.7

Table 84: SERIES Cuthbert sl

Location: County Lee
Town Plantersville
Region: Upper Coastal Plain: Blackland
Position: Middle 1/3 slope
Elevation: 375'

Aspect: S-75-E
Slope %: 8
Drainage: Moderately well
Parent Material: Coffee fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 3	62.2	27.1	10.7	sl	1.33	0.60	14.37
2	B^{p}_{21}	3- 9	33.0	35.4	31.6	cl	0.62	0.74	14.18
3	B_{22}	9-16	45.0	22.2	32.8	cl	0.38	0.16	16.12
4	B_{3g}	16-24	45.4	19.2	35.4	scl	0.46	0.14	17.21
5	C_{1g}	24-32	55.1	14.8	30.1	scl	0.46	0.04	18.48

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.1	6.9	2.9	0.9	0.1	0.2	4.5	59.42	47.67
2	4.8	17.9	3.0	1.3	0.1	0.3	14.9	26.26	23.98
3	4.7	19.0	3.5	1.3	0.2	0.2	16.0	27.37	24.53
4	4.8	23.5	4.5	1.5	0.3	0.3	18.3	28.09	26.51
5	4.8	21.0	7.8	1.8	0.5	0.2	13.9	49.05	42.56

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.51	29.2	27.6	21.4	17.4	16.2	11.0	9.8
2	1.49	41.0	34.9	34.2	30.7	30.3	25.5	24.2
3	1.53	40.6	36.0	33.8	31.8	30.6	25.9	25.3
4	1.49	43.5	40.9	37.7	35.2	33.7	30.9	29.3
5	1.60	37.1	35.6	31.7	29.2	27.6	24.3	23.0

Table 85: SERIES Cuthbert cl

Location: County Itawamba Town Mantachie	Aspect: S-60-E
Region: Upper Coastal Plain	Slope %: 8
Position: Middle 1/3 slope	Drainage: Somewhat poorly
Elevation: 390'	Parent Material: Eutaw fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0- 2	42.5	29.3	28.2	cl	2.35	1.13	48.76
2	B_2^p	2-15	9.4	37.1	53.5	c	0.95	0.20	51.29
3	C_{21g}	15-27	6.7	39.0	54.3	c	0.62	0.40	54.29
4	C_{22g}	27-48	64.2	16.9	18.9	sl	0.18	0.42	38.22

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.8	26.3	8.9	7.1	0.1	0.6	14.9	63.49	52.85
2	4.6	44.9	11.6	11.0	0.2	1.4	26.1	53.90	48.11
3	4.7	53.6	10.6	12.3	0.2	1.4	26.6	45.71	47.95
4	4.5	25.5	5.9	8.0	0.2	0.6	13.4	57.65	52.31

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.27	39.2	37.4	33.8	31.5	27.3	26.4	24.9
2	1.02	53.5	46.1	45.5	42.5	41.7	38.9	37.7
3	1.02	55.4	49.1	46.7	44.3	43.7	42.0	41.4
4	1.41	46.1	38.5	35.6	30.8	28.0	26.2	24.7

Table 86: SERIES Pheba sl

Location: County Clay Town Cedar Bluff		Aspect: N-45-E
Region: Upper Coastal Plain: Blackland		Slope %: 2
Position: Ridge flat		Drainage: Somewhat poorly
Elevation: 225'		Parent Material: Alluvium over Demopolis fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 3	61.6	35.4	3.0	sl	1.05	0.62	5.71
2	B_1	3-16	46.6	46.1	7.3	sl	0.32	0.43	3.97
3	B_{2g}	16-26	37.1	45.8	17.1	l	0.32	0.15	4.19
4	B_{3xg}	26-41	35.8	47.2	17.0	l	0.32	0.15	5.65

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.6	3.0	0.3	0.1	0.0	0.1	3.6	16.67	12.20
2	5.0	2.0	0.2	0.1	0.0	0.0	2.4	15.00	11.11
3	4.9	5.3	1.5	0.4	0.1	0.1	4.9	39.62	30.00
4	4.9	5.8	0.8	0.4	0.1	0.1	6.0	24.14	18.92

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.26	26.4	20.2	13.2	9.9	7.4	7.0	3.7
2	1.46	28.7	23.2	19.1	12.7	10.3	8.2	4.8
3	1.54	39.1	33.1	26.7	20.9	17.9	14.6	11.5
4	1.56	39.7	38.1	29.6	24.8	20.6	15.4	11.0

Table 87: SERIES Pheba sil

Location: County Noxubee
Town Brooksville
Region: Upper Coastal Plain: Blackland
Position: Ridge flat
Elevation: 210'

Aspect: North
Slope %: 2
Drainage: Somewhat poorly
Parent Material: Alluvium over Prairie Bluff fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 2	42.8	54.6	2.6	sil	2.60	0.43	2.69
2	B_1	2- 6	40.3	54.5	5.1	sil	0.55	0.16	1.61
3	B_{2g}	6-21	34.7	55.3	10.0	sil	0.32	0.18	1.81
4	B_{3xg}	21-63	28.8	56.0	15.2	sil	0.32	0.16	8.52

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.6	5.6	0.3	0.1	0.1	0.1	7.3	10.71	7.59
2	5.0	1.6	1.0	0.1	0.1	0.0	2.1	75.00	36.36
3	5.4	3.3	1.3	0.2	0.0	0.1	2.8	48.48	36.36
4	4.8	5.5	0.7	0.2	0.1	0.1	5.6	20.00	16.42

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.08	27.6	25.6	18.5	13.4	11.0	5.9	5.3
2	1.42	28.2	26.4	20.1	13.2	10.8	5.3	3.1
3	1.60	34.2	32.7	26.2	16.9	13.7	9.9	7.3
4	1.60	35.8	32.6	26.8	24.2	21.1	16.9	15.6

Table 88: SERIES Shubuta ls

Location: County Itawamba Town Fulton	Aspect: S-70-E
Region: Upper Coastal Plain	Slope %: 13
Position: Upper 1/3 slope	Drainage: Well
Elevation: 450'	Parent Material: Eutaw fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 8	76.0	20.4	3.6	ls	3.00	0.44	4.06
2	B_{21t}	8-23	36.0	10.0	54.0	c	1.25	0.19	14.38
3	B_{22t}	23-46	42.9	8.8	48.3	c	0.55	0.16	15.11

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.3	2.3	0.6	0.2	0.1	0.1	2.8	43.48	26.32
3	5.3	16.4	1.4	2.4	0.1	0.2	15.5	25.00	20.92

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.28	18.6	17.9	10.2	7.9	6.9	4.6	3.6
2	1.27	40.7	40.3	39.9	37.7	37.3	36.8	33.6
3	1.45	43.5	40.4	39.3	38.6	38.0	37.0	36.1

Table 89: SERIES Shubuta sl

Location: County Neshoba
Town Neshoba
Region: Upper Coastal Plain
Position: Upper 1/3 slope
Elevation: 480'

Aspect: S-70-W
Slope %: 13
Drainage: Well
Parent Material: Neshoba fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 3	68.0	27.6	4.4	sl	1.33	0.45	3.93
2	B_2	3-37	45.8	11.4	42.8	sc	0.46	0.15	34.95
3	B_3	37-71	31.0	0.5	68.5	scl	0.25	0.16	13.05

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.0	3.8	0.7	0.2	0.0	0.1	5.3	26.32	15.87
2	5.3	9.6	1.2	1.6	0.0	0.3	10.0	32.29	23.66
3	5.0	6.9	0.0	0.8	0.0	0.1	7.3	13.04	10.98

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.02	21.8	14.3	9.3	6.4	5.7	3.2	1.8
2	1.33	35.8	29.7	26.9	25.8	25.1	22.6	21.7
3	1.60	33.3	27.9	26.0	24.7	23.7	19.9	19.3

Table 90: SERIES Shubuta sl

Location: County Lauderdale Town Obidiah	Aspect: N-55-W
	Slope %: 9
Region: Upper Coastal Plain	Drainage: Well
Position: Upper 1/3 slope	Parent Material: Wilcox fm
Elevation: 500'	

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A	0-11	62.7	31.0	6.3	sl	1.25	0.59	10.87
2	B^{p}_{21t}	11-18	46.3	28.3	25.4	l	0.62	0.33	40.86
3	B_{22t}	18-34	36.4	24.0	39.6	cl	0.46	0.16	57.24
4	B_{3t}	34-86	41.4	21.4	37.2	cl	0.46	0.03	36.04

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	3.8	0.3	0.2	0.1	0.1	4.3	18.42	14.00
2	5.2	7.8	2.0	1.9	0.1	0.3	5.3	55.13	44.79
3	5.4	11.3	2.7	3.1	0.1	0.4	6.8	55.75	48.09
4	5.1	14.3	2.1	3.3	0.1	0.3	10.5	40.56	35.58

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15. atm.
1	1.20	21.2	18.0	13.9	11.0	10.5	6.7	6.6
2	1.64	33.9	29.5	25.4	23.8	23.3	22.0	19.3
3	1.56	44.2	39.2	33.8	31.8	30.2	28.5	26.5
4	1.36	39.7	37.3	36.0	35.0	34.4	31.4	31.1

Table 91: SERIES Shubuta c, eroded

Location: County Lauderdale
Town Ponta
Region: Upper coastal plain
Position: Middle 1/3 slope
Elevation: 275'

Aspect: S-25-E
Slope %: 18
Drainage: Moderately well
Parent Material: Wilcox fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	B_{2t}	0- 8	20.2	27.7	52.1	c	1.25	0.36	47.64
2	B_3	8-18	41.1	21.0	37.9	cl	0.86	0.25	52.64
3	C_{1g}	18-27	33.5	28.9	37.6	cl	0.70	0.26	49.70
4	C_{2g}	27-46	27.2	39.1	33.7	cl	0.38	2.49	39.89

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.0	27.3	5.0	7.3	1.0	0.8	16.3	51.65	46.38
2	4.9	23.1	2.5	6.2	0.1	0.5	17.5	40.26	34.70
3	4.8	24.1	2.0	6.6	0.1	0.5	18.3	38.17	33.45
4	4.8	23.8	0.6	6.9	0.2	0.5	17.5	34.45	31.91

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.23	47.1	44.7	42.1	40.6	39.7	37.0	35.3
2	1.27	46.2	44.5	41.3	39.1	38.1	35.7	33.5
3	1.31	53.1	51.4	47.3	44.7	43.7	41.1	37.9
4	1.29	52.1	46.6	46.2	44.8	43.7	38.6	32.9

Table 92: SERIES Shubuta sl

Location: County Jasper
Town Bay Springs
Region: Lower Coastal Plain
Position: Lower 1/3 slope
Elevation: 375'

Aspect: S-20-E
Slope %: 7
Drainage: Moderately well
Parent Material: Forest Hill fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	62.8	29.6	7.6	sl	3.96	0.80	9.77
2	B_{2t}	4-17	17.6	23.4	59.0	c	0.86	0.14	12.59
3	B_{3tg}	17-50	32.6	19.8	47.6	c	0.55	0.30	13.77
4	C_{2g}	50+	38.7	21.5	39.8	cl	0.55	0.15	15.61

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.6	10.5	4.5	1.2	0.1	0.2	7.9	57.14	43.17
2	4.9	19.5	2.2	2.7	0.1	0.2	17.3	26.80	23.11
3	4.9	21.4	2.9	3.2	0.1	0.2	16.8	29.91	27.59
4	5.0	21.0	5.8	4.4	0.2	0.2	12.0	50.48	46.90

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.15	29.1	25.5	18.3	16.9	16.5	15.3	12.2
2	1.39	48.0	45.6	42.7	41.1	40.2	36.9	34.4
3	1.52	52.6	51.2	47.4	41.4	38.9	36.8	35.3
4*	1.50		47.5	46.5	45.1	37.6	36.0	30.2

*Disturbed sample

Table 93: SERIES Shubuta sl

Location: County Jasper
Town Rose Hill
Region: Upper Coastal Plain
Position: Ridge
Elevation: 350'

Aspect: East
Slope %: 5
Drainage: Moderately well
Parent Material: Cockfield fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 6	67.6	28.6	3.8	sl	0.95	0.71	5.55
2	B_{2t}	6-17	28.1	11.5	60.4	c	0.86	0.35	22.18
3	B_{3tg}	17-41	37.8	7.1	55.1	c	0.55	0.28	23.76
4	C_{1g}	41-57	43.8	8.7	47.5	sc	0.38	0.71	21.20

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	3.5	0.7	0.2	0.0	0.1	3.4	28.57	22.73
2	5.1	20.5	8.5	4.8	0.2	0.3	11.6	67.32	54.33
3	4.9	20.4	3.0	3.0	0.1	0.3	16.9	31.37	24.47
4	4.9	21.0	2.2	3.1	0.2	0.3	18.8	27.62	23.58

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.44	29.1	23.6	14.9	8.9	7.9	5.4	4.1
2	1.18	53.2	47.5	46.2	45.6	44.3	40.5	38.2
3	1.38	52.6	49.2	47.9	47.0	46.5	41.4	39.0
4	1.44	56.0	55.4	49.1	45.8	43.4	39.6	38.2

Non-Modal Profiles

The following nine profiles are representative of the difficulties encountered in soil classification and soil mapping. The Loring profile was originally classified in the Ora series, the second Boswell profiles as a Shubuta, the Myatt as an Almo, and the Cuthbert profile as a Susquehanna.

The textural and chemical analyses provided information that necessitated reclassification of approximately one-third of the profiles sampled in this study; ten percent of these reclassifications resulted in inter-Order shifts.

The profiles in this section, even after reclassification, do not meet one or more criteria for the series into which they were placed. The physical situations, however, do exist and for the purposes of site classification must be recognized and evaluated.

Table 94: SERIES ? (Loring sil)

Location: County Franklin
Town Little Springs
Region: Thin Loess
Position: Upper 1/3 slope
Elevation: 380'

Aspect: S-45-W
Slope %: 10
Drainage: Moderately well
Parent Material: Alluvium over Hattiesburg fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 5	34.0	60.6	5.4	sil	1.55	0.53	13.86
2	B_{2t}	5-18	13.5	59.4	27.1	sicl	0.55	0.17	23.93
3	B_{3xg}	18-52	9.5	65.2	25.3	sil	0.38	0.22	18.94

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.6	4.6	1.5	0.6	0.1	0.1	3.8	50.00	37.70
2	5.4	10.1	1.8	2.9	0.1	0.2	7.5	49.50	40.00
3	5.2	12.3	0.7	4.0	0.1	0.2	4.0	40.65	55.56

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.36	32.5	31.5	20.0	15.3	12.8	9.2	7.8
2	1.52	36.6	34.9	32.9	30.3	29.6	28.7	26.2
3	1.48	42.3	40.7	39.4	36.9	35.3	29.2	22.9

Table 95: SERIES ? (Boswell fsl)

Location: County Lincoln
Town Brookhaven
Region: Lower Coastal Plain
Position: Upper 1/3 slope
Elevation: 370'

Aspect: S-60-W
Slope %: 16
Drainage: Moderately well
Parent Material: Hattiesburg fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 2	54.3	40.7	5.0	fsl	2.35	0.68	4.95
2	A_2	2- 7	49.2	39.5	11.3	l	0.62	0.27	6.67
3	B_2	7-19	46.7	22.6	30.7	cl	0.38	0.03	17.98
4	B_{3g}	19-34	44.6	25.9	29.5	cl	0.32	0.03	20.34
5	C_{2g}	34-48	25.3	38.5	36.2	cl	0.25	0.03	27.15

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.6	5.0	1.2	1.0	0.0	0.1	4.8	46.00	32.39
2	5.0	17.9	4.2	5.3	0.1	0.3	11.1	55.31	47.14
3	4.9	20.3	3.8	6.8	0.1	0.3	12.6	54.19	46.61
4	4.8	26.6	5.5	9.9	0.2	0.5	13.3	60.53	54.76
5	4.8	6.1	1.5	0.5	0.1	0.1	6.0	36.07	26.83

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1*	1.15		24.1	15.3	12.5	11.7	7.4	4.8
2	1.37	28.6	25.7	18.7	13.3	11.3	6.7	4.6
3	1.47	41.5	37.4	32.8	30.0	28.5	27.1	26.5
4	1.46	46.4	38.7	36.1	32.1	31.4	29.1	27.4
5	1.48	52.8	44.2	40.4	35.9	35.2	32.9	31.0

*Disturbed sample

Table 96: SERIES ? (Boswell fsl)

Location: County Lawrence
Town Monticello
Region: Lower Coastal Plain
Position: Lower 1/3 slope
Elevation: 225'

Aspect: N-75-W
Slope %: 20
Drainage: Somewhat poorly
Parent Material: Hattiesburg fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 2	58.0	37.0	5.0	fsl	4.05	0.74	5.55
2	A_2	2- 7	59.1	32.1	8.8	fsl	1.05	0.29	2.59
3	B_{2tg}	7-12	23.8	32.5	43.7	c	0.70	0.03	22.92
4	B_{3tg}	12-20	38.8	25.3	35.9	cl	0.62	0.03	22.76
5	C_{2tg}	20-37	43.3	27.8	28.9	cl	0.46	0.04	19.27

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.8	11.8	2.8	1.0	0.1	0.1	9.8	33.90	28.99
2	4.7	4.3	0.3	0.3	0.0	0.1	4.8	16.28	12.73
3	4.6	22.5	2.2	4.8	0.1	0.4	17.8	33.33	29.64
4	4.4	20.6	2.7	4.9	0.1	0.4	15.5	39.32	34.32
5	4.5	16.6	3.0	5.2	0.2	0.3	10.8	52.41	44.62

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.83	33.3	22.9	17.7	12.5	10.3	9.7	7.2
2	1.43	24.9	19.0	14.2	11.9	11.2	6.9	5.3
3	1.51	42.6	38.5	37.3	35.6	34.7	31.8	28.8
4	1.50	42.0	38.1	34.8	32.9	32.1	30.0	24.1
5	1.59	40.7	30.6	28.5	26.2	24.8	24.2	18.4

Table 97: SERIES ? (Rumford or Troup)

Location: County Lauderdale
Town Meridian
Region: Upper Coastal Plain
Position: Upper 1/3 slope
Elevation: 525'

Aspect: N-40-E
Slope %: 4
Drainage: Somewhat excessively
Parent Material: Wilcox fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0-10	85.1	9.4	5.5	ls	0.95	0.76	7.22
2	A_2	10-23	82.2	11.5	6.3	ls	0.38	0.54	5.20
3	A_3	23-50	79.5	15.0	5.5	ls	0.32	0.82	5.31
4	B_2	50-87	58.6	25.0	16.4	sl	0.55	0.31	12.53

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	5.6	3.5	1.2	0.3	0.0	0.1	3.0	45.71	34.78
2	5.4	1.5	0.7	0.2	0.1	0.0	1.4	66.67	41.67
3	5.4	2.1	0.8	0.4	0.1	0.1	1.9	66.67	42.42
4	5.0	5.3	0.2	0.7	0.1	0.1	5.3	20.75	17.19

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.10	12.3	11.0	7.4	6.6	6.4	3.8	3.2
2*	1.35		10.2	6.2	5.9	5.8	3.9	2.6
3*	1.37		13.2	7.5	6.9	6.0	4.8	3.6
4	1.58	25.1	21.8	18.2	16.7	15.7	13.9	12.4

*Disturbed sample

Table 98: SERIES ? (Rumford ls)

Location: County Clarke
Town Pachuta
Region: Upper Coastal Plain
Position: Middle 1/3 slope
Elevation: 320'

Aspect: S-30-E
Slope %: 13
Drainage: Well
Parent Material: Colluvium over Cockfield fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_1	0- 5	78.8	17.7	3.5	ls	2.47	1.08	2.58
2	A_2	5-26	73.6	22.4	4.0	ls	0.38	0.52	2.39
3	IIB_{21t}	26-32	55.5	26.7	17.8	sl	0.12	0.33	18.61
4	$IIIB_{22}$	32-42	78.8	10.4	10.8	sl	0.18	0.29	11.31

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.8	6.2	0.1	0.2	0.1	0.1	5.6	8.06	8.20
2	5.1	1.5	0.2	0.2	0.1	0.1	1.4	40.00	30.00
3	4.8	5.3	1.2	0.9	0.2	0.2	5.6	47.17	30.86
4	4.8	3.5	0.8	0.7	0.1	0.1	3.4	48.57	33.33

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.99	27.5	19.5	11.0	9.2	7.5	5.0	4.3
2	1.32	25.2	15.7	11.1	7.9	5.9	4.6	2.5
3	1.66	30.5	28.2	25.1	22.7	21.4	20.8	16.3
4	1.49	26.5	18.6	15.5	14.6	14.4	11.9	5.8

Table 99: SERIES ? (Rains sil)

Location: County Hancock
Town Pearlington
Region: Coastal Flatwoods
Position: Ridge
Elevation: 20'

Aspect: S-30-E
Slope %: 1
Drainage: Somewhat poorly
Parent Material: Coastal deposits

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

		Depth,	Particle size dist.,%				Organic Matter	lbs. per acre inch	
No.	Horizon	in.	Sand	Silt	Clay	Texture	%	Avail.P	Exch.K
1	A_1	0- 4	28.8	65.9	28.8	sil	6.04	2.32	6.24
2	B_{21g}	4-13	29.2	65.8	29.2	sil	1.05	0.28	0.96
3	B_{22g}	13-30	27.6	65.1	27.6	sil	0.62	0.03	1.05
4	C_g	30+	25.9	64.0	25.9	sil	0.46	0.04	2.07

CHEMICAL DATA

		C.E.C.,	Exchangeable cations, me./100g.					% Base Saturation	
No.	pH	me./100g.	Ca	Mg	Na	K	H	metals/C.E.C.	metals/cations
1	4.0	13.9	0.5	0.4	0.2	0.1	18.0	8.63	6.25
2	4.4	3.5	0.1	0.0	0.1	0.2	5.5	5.71	3.51
3	4.4	4.3	0.1	0.1	0.1	0.3	5.9	6.98	4.84
4	4.6	6.0	0.1	0.2	0.8	0.0	6.8	18.33	13.92

SOIL MOISTURE PROPERTIES

		Percent moisture by volume at tension of:						
No.	Bulk Density g/cc	60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.04	46.6	42.1	33.9	20.9	17.9	15.0	12.7
2	1.41	31.2	28.7	22.7	14.4	12.1	8.4	7.6
3	1.54	37.4	32.3	28.8	17.8	15.3	8.7	7.6

Table 100: SERIES ? (Myatt sil)

Location: County Lowndes
Town Caledonia
Region: Upper Coastal Plain
Position: Terrace
Elevation: 245'

Aspect: N-E
Slope %: 1
Drainage: Poorly
Parent Material: Recent Alluvium

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	17.8	75.0	7.2	sil	3.69	0.87	4.44
2	B_g	4-15	18.9	76.5	4.6	sil	0.78	0.61	4.19
3	C_{1g}	15-48	13.0	64.8	22.2	sil	0.46	0.00	7.16

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.5	6.9	0.3	0.2	0.1	0.1	8.6	10.14	7.53
2	4.8	2.0	0.1	0.1	0.1	0.0	2.4	15.00	11.11
3	5.0	10.6	0.2	0.3	0.6	0.1	11.9	11.32	9.16

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.98	45.6	40.4	35.8	28.3	25.3	23.2	19.2
2	1.54	39.6	39.3	32.2	23.3	14.4	11.4	6.4
3	1.58	46.8	43.5	40.5	33.8	31.9	31.1	21.3

Table 101: SERIES ? (Cuthbert sil)

Location: County Lawrence
Town Monticello
Region: Lower Coastal Plain
Position: Upper 1/3 slope
Elevation: 370'

Aspect: N - 70 - W
Slope %: 12
Drainage: Somewhat poorly
Parent Material: Hattiesburg fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 4	40.0	52.4	7.6	sil	2.47	0.38	5.76
2	B_{2g}	4-19	17.6	44.1	38.3	sicl	0.78	0.04	19.75
3	C_{2g}	19-42	13.9	49.0	37.1	sicl	0.46	0.35	18.33
4	C_3	42-56	27.0	43.6	29.4	cl	0.55	0.13	15.25

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.9	8.1	2.4	1.1	0.1	0.1	6.9	45.68	34.91
2	4.7	18.6	4.5	6.1	0.2	0.3	9.3	59.68	54.41
3	4.7	20.5	5.8	8.8	0.3	0.3	6.3	74.15	70.70
4	4.8	17.9	5.8	7.0	0.4	0.3	7.8	75.42	63.38

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	0.96	25.7	22.0	13.0	10.5	9.7	7.2	5.5
2	1.71	37.4	36.3	33.5	32.5	31.8	28.3	26.5
3	1.74	35.7	32.0	29.3	28.7	28.0	25.7	23.2

Table 102: SERIES ? (Shubuta sl)

Location: County Simpson
Town Pinola
Region: Lower Coastal Plain
Position: Middle 1/3 slope
Elevation: 300'

Aspect: S-60-E
Slope %: 6
Drainage: Moderately well
Parent Material: Catahoula fm

PARTICLE SIZE ANALYSIS AND PARTIAL CHEMICAL DATA

No.	Horizon	Depth, in.	Particle size dist.,% Sand	Silt	Clay	Texture	Organic Matter %	lbs. per acre inch Avail.P	Exch.K
1	A_p	0- 9	57.0	38.5	4.5	sl	2.08	0.50	4.57
2	B_2	9-17	30.8	28.1	41.1	c	0.70	0.03	10.95
3	B_{3g}	17-30	15.4	33.1	51.5	c	0.46	0.04	16.43
4	C_2	30+	10.4	19.0	70.6	c	0.46	0.04	43.89

CHEMICAL DATA

No.	pH	C.E.C., me./100g.	Exchangeable cations, me./100g. Ca	Mg	Na	K	H	% Base Saturation metals/C.E.C.	metals/cations
1	4.8	5.3	1.1	0.3	0.1	0.1	5.6	30.19	22.22
2	4.7	16.5	3.3	3.4	0.1	0.2	11.5	42.42	37.84
3	4.7	20.3	2.4	6.3	0.3	0.3	14.3	45.81	39.41
4	4.3	21.0	0.5	11.5	0.5	0.3	11.9	60.95	51.82

SOIL MOISTURE PROPERTIES

No.	Bulk Density g/cc	Percent moisture by volume at tension of: 60 cm	1/10 atm.	1/3 atm.	2/3 atm.	1 atm.	4 atm.	15 atm.
1	1.26	29.9	27.4	19.6	15.1	13.8	12.4	11.7
2	1.51	35.9	34.0	32.6	30.7	30.2	29.1	28.2
3	1.56	43.4	41.5	35.8	33.1	31.8	29.0	26.9
4	1.55	46.6	45.1	42.9	40.7	38.3	35.5	34.3

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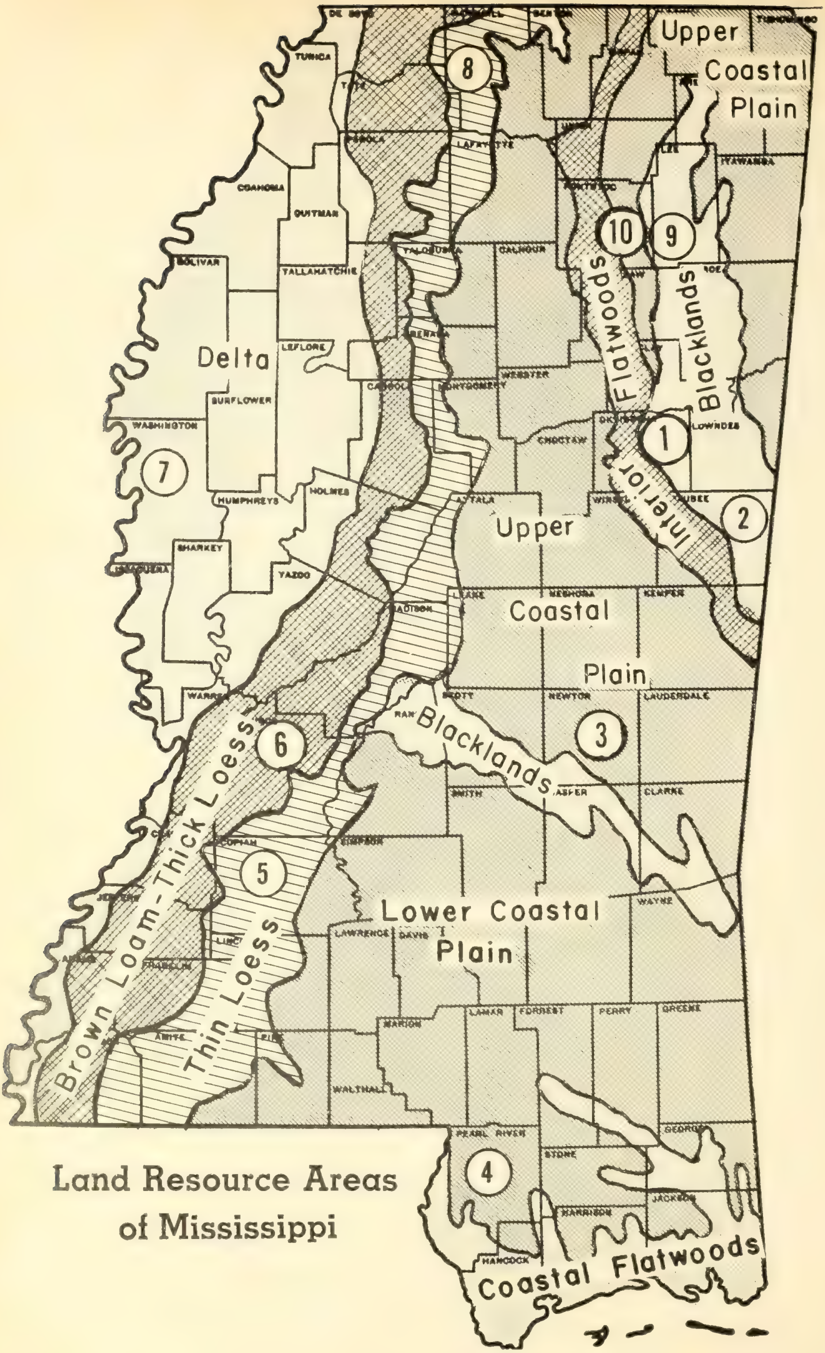

Upper
Coastal
Plain
8
10
9
Flatwoods
Blacklands
Delta
7
1
Interior
2
Upper
Coastal
Plain
3
Blacklands
6
Brown Loam-Thick Loess
5
Thin Loess
Lower Coastal
Plain
4
Coastal Flatwoods
DE SOTO
TISHOMINGO
TUNICA
PANOLA
LAFAYETTE
ITAWAMBA
COAHOMA
QUITMAN
BOLIVAR
TALLAHATCHIE
CALHOUN
LEFLORE
WEBSTER
MONTGOMERY
SUNFLOWER
WASHINGTON
LOWNDES
CHOCTAW
HUMPHREYS
HOLMES
ATTALA
SHARKEY
YAZOO
NESHOBA
KEMPER
MADISON
SCOTT
NEWTON
LAUDERDALE
SMITH
CLARKE
COPIAH
SIMPSON
WAYNE
LAWRENCE
DAVIS
FRANKLIN
LAMAR
FORREST
PERRY
GREENE
MARION
AMITE
WALTHALL
PEARL RIVER
GEORGE
STONE
JACKSON
HARRISON
HANCOCK

Land Resource Areas of Mississippi

This map shows land resource areas of the state and how Experiment Station locations fit into them. Number 1 is the main station at State College. Branch stations are: 2 Brooksville, 3 Newton, 4 Poplarville, 5 Crystal Springs, 6 Raymond, 7 Stoneville, 8 Holly Springs, 9 Verona, and 10 Pontotoc.

CROP AND FERTILIZER RECOMMENDATIONS FOR MISSISSIPPI

Crop and fertilizer recommendations are made periodically by the Mississippi Agricultural Experiment Station. These recommendations incorporate the latest research findings at State College and the Branch Experiment Stations. Included is information on varieties and fertilization and seeding practices for crops commonly grown in the state, as well as information on lawns, turf grasses and home gardens.

Because of varying soil and weather condition and other local factors, no single crop variety or fertilizer recommendation will fit the entire state perfectly; nonetheless, these general recommendations are useful guides for crop production. Of course these recommendations assume that other good farming practices will be followed.

If more specific information is needed, it may be obtained from the Extension Service, the Experiment Station, your County Agent, or other trained agricultural workers in your locality.

Soil Testing Service

The farmer gets maximum profit from fertilizer only when the right kind and amount are used on each field. Through the Mississippi State Soil Testing Service every farmer can get this information as well as information on liming practices. Furthermore, the Soil Testing Service makes recommendations for exceptionally high production goals which may not be provided for in the general recommendations.

Soil testing is a free service.. Soil sample boxes, mailing cartons, and instructions for collecting samples are available in each county agent's office and the offices of other agricultural agencies.

Plant Nutrients

Plant nutrients can be divided into two groups: (1) Those elements used by crops in relatively large amounts; and (2) those needed in very small amounts. The first group includes nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. These are usually subdivided into the primary fertilizer nutrients — nitrogen, phosphorus, and potassium — and the secondary fertilizer nutrients — calcium. magnesium, and sulfur. The primary nutrients are applied to crops either as straight materials or as mixed fertilizers. Straight materials are those which contain only one fertilizer nutrient. Some examples of straight materials are listed below:

Material	Total Nitrogen (N)
Ammonium nitrate	33.5%
Anhydrous ammonia	82%
Nitrate of soda	16%
	Available Phosphate (P_2O_5)
Superphosphate	18 to 20%
	Available Potash (K_2O)
Muriate of potash	60%

Mixed fertilizers contain two or more of the fertilizer nutrients. Each fertilizer bag is labeled with a set of numbers to show how much of each nutrient it contains. The first number shows the percentage nitrogen (N), the second percentage available phosphate (P_2O_5), and the third the percentage water-soluble potash (K_2O). One hundred pounds of a 5-10-10 fertilizer thus contains 5 lbs. of total N, 10 lbs. of available P_2O_5, and 10 lbs. of available K_2O. The fertilizer ratio refers to the relative amounts of these nutrients. The fertilizer grade gives the guaranteed amounts of each fertilizer nutrient as a percentage. For example 8-8-8 and 10-10-10 are two different grades in a 1-1-1 ratio. Similarly, 6-8-8 and 9-12-12 are two grades in a 3-4-4 ratio. Materials such as ordinary superphosphate may be labeled 0-20-0.

At present fertilizer nutrients are either expressed as the oxide, phosphorus as phosphorus pentoxide (P_2O_5), or as the element, nitrogen as N, but there is a trend toward expressing all fertilizer nutrients on the elemental basis. Accordingly, phosphate would be expressed as (P) and potash as (K) by using the chemical symbols for phosphorus and potassium, respectively. The primary "fertilizer nutrient" when listed on the elemental basis would then be shown as N-P-K on the fertilizer bag. Some fertilizers are labeled both ways to familiarize consumers with the new labeling trend. When labeled on an elemental basis a 10-20-20 (N-P_2O_5-K_2O) would become a 10-8.2-16.5 (N-P-K). The conversion factors for potash are: K_2O x 0.86 = K; K x 1.21 = K_2O. The conversion factors for phosphate are: P_2O_5 x 0.436 = P; P x 2.29 = P_2O_5. Only the method of labeling is changed not the plant nutrient value of the fertilizer.

For the most part fertilizer recommendations are given in this bulletin as pounds of N, P_2O_5, and K_2O needed per acre. Usually the farmer will have a choice of more than one fertilizer grade. For example, 48 lbs. N, 48 lbs. P_2O_5, and 48 lbs. K_2O may be supplied with 600 lbs. of 8-8-8 or 400 lbs. of 12-12-12. Since some deviation from the general recommendation does not affect net profit greatly, it is not necessary to apply exactly the amounts of N, P_2O_5, or K_2O indicated.

Both the need for and the presence of the secondary nutrients in fertilizers is variable. Research has shown that sulfur deficiency is likely to occur on soils in the Hill Section when sulfur - free fertilizers are used. Accordingly, sulfur is recommended for crop production in this area, especially for cotton and legumes. A convenient and economical way to get the sulfur is to use mixed fertilizers that contain sulfur. Most solid mixed fertilizers sold in Mississippi contain adequate sulfur, but most liquid mixed fertilizers do not unless special provision is made for the addition of sulfur.

Scattered instances of sulfur deficiency have been observed in the Delta Area. These deficiencies have been associated with land leveling and very sandy soils that are low in organic matter. Since mixed fertilizers are less commonly used in this area, other sources of sulfur may be more economical or convenient to apply. Sources of sulfur that may be used include gypsum, elemental sulfur, ammonium sulfate, and ordinary superphosphate.

Calcium and magnesium are usually applied to soils as agricultural limestone, although a major objective of liming is to neutralize soil acidity. A more complete discussion of liming is given elsewhere. On soils needing magnesium but not requiring lime, the addition of a water-soluble source of magnesium to mixed fertilizers is a very convenient method of applying the magnesium.

The second group of nutrients is referred to variously as "trace elements," "minor elements," and "micronutrients." They are needed by crops in very small amounts. Included are iron, manganese, zinc, copper, boron, molybdenum and chlorine. Thus far, only three (zinc, boron, and molybdenum) of these have found to be deficient to an appreciable extent for crop production in Mississippi. These deficiences have not occurred on all crops and have been restricted almost entirely to the Hill Section. Specific recommendations for micronutrient are given later for crops which need them.

Solid VS Liquid Mixed Fertilizers: Mixed fertilizers are available in both solid and liquid forms. Liquid fertilizers have given, or would be expected to give excellent results in most cases, but they are no more effective than many, if not most, solid mixed fertilizers.

Inferiority of some solid mixed fertilizers to liquid mixed fertilizers and to other solids may be attributed primarily to the reduced effectiveness of the phosphate component of these fertilizers. Only highly water soluble phosphates are of necessity, used in the formulation of liquid mixed fertilizers, but the water solubility as well as other characteristics of the phosphate materials in solid mixed fertilizer may vary widely. All highly water soluble phosphates are very effective fertilizers but all those of low water solubility are not.

Solid mixed fertilizers formulated with ammonium phosphates and non-ammoniated superphosphate contain a very high percentage of their phosphorus in a water-soluble form and are just as effective as liquid mixed fertilizers. Ammoniation of ordinary and concentrated superphosphates to add nitrogen during the formulation of mixed fertilizers, which is a common practice, converts some of the highly effective water-soluble monocalcium phosphate to water-insoluble calcium phosphate some of which may be somewhat less effective for crop production. This is particularly true with ordinary superphosphate (20%) because of the formation of an apatite-like calcium phosphate the quantity of which increases progressively with increasing ammoniation. In a sense new rock phosphate is formed. Consequently, mixed fertilizers formulated from highly ammoniated ordinary superphosphate are not as effective as liquid mixed fertilizer, or other high quality solids. Unfortunately, most of the phosphorus in the apatite-like phosphates formed upon ammoniation of ordinary superphosphate is determined to be "available" by the chemical method currently used for control purposes.

With the sources of phosphorus commonly used in the formulation of mixed fertilizers in Mississippi, farmers can be reasonably certain of good results if 50 to 60 percent of the "available" phosphorus is also water-soluble. Some manufacturers give the water-soluble phosphorus content of their fertilizers though this is not required by law.

A substantial amount of nitrogen in liquid mixed fertilizers is derived from urea and/or ammonium nitrate. As will be indicated later nitrogen solutions containing urea or urea and ammonium nitrate have been much less effective for surface application to summer pastures than either solid urea or ammonium nitrate. Therefore, liquid complete fertilizers would not be expected to be as effective for summer pastures as solid complete (NPK) fertilizers.

Soil pH and Liming

Excessive soil acidity and associated factors reduce crop yields. A recent survey made by the Mississippi Soil Testing Laboratory showed that some 70 percent of the soils tested needed lime for legumes and 35 percent for non-legumes.

The degree of acidity or alkalinity of a soil is expressed by its pH; values below 7.0 indicate an acid soil, above 7.0 an alkaline soil. Soil reaction, or pH, affects the availability of some of the more important plant nutrients in the soil. Phosphate is much less available in very acid soils than in slightly acid to mildly alkaline soils. In very strongly acid soils, (pH below 5.0) certain elements such as manganese and aluminum may be changed to forms that are absorbed in such quantities as to be toxic to plants. On the other hand micronutrients such as iron, manganese, boron, and zinc rapidly become less available as the pH of the soil is increased above 6.0. This is one reason why one must not overlime. Experience has shown that overliming injury in Mississippi is very likely to be associated with deficiences of boron and zinc. In the case of cotton and legumes, it is very likely to be due to boron deficiency and with corn, and perhaps other grasses, to zinc deficiency.

It has been found that soils with a pH of 6.0 or higher are well supplied with lime and at the same time the other nutrients are maintained in forms sufficiently available to crops. If the pH is less than 5.0, the soil is very strongly acid and is extremely deficient in lime. Most non-legumes grow best at soil pH values of 5.5 and above while most legumes do best if the pH is maintained above 6.0. Alfalfa does best at soil pH values above 6.5.

The amount of lime required to raise the pH of the soil to a desired value depends both on the initial pH and the lime holding capacity of the soil. For soils of Mississippi having a pH of 5.5 or slightly below, the application of 3000 pounds of lime per acre to sandy loam soils, 5000 to 6000 pounds to loam and silt loam soils, and 7000 to 9000 pounds to clay loam and clay soils, respectively, has been satisfactory in correcting lime deficiency for legumes. Since about two-thirds of the soils of the state have pH values of 5.5 or above, and 95% above 5.0, these rates of lime would bring the pH of most of the soils of the state within the range that is favorable for legumes. But such a program would result in the application of too much lime to some soils and not enough to others. For example, the black upland soils and the bottom soils of the Northeast Blackland area seldom need lime even for legumes. The best practice is to test the soils for pH and lime requirement and apply lime as needed to maintain the pH within the desired range.

Lime is lost naturally from the soil by crop removal and by leaching. The use of acid forming sources of nitrogen and the turning under of legumes as soil builders accelerates leaching losses. For example, 100 pounds of nitrogen from such sources as ammonium nitrate, anhydrous ammonia and urea will cause the loss of calcium and other bases equal to about 200 pounds of lime. When applied annually at this rate, the loss would amount to one ton of lime every ten years due to fertilizer alone. Because of these losses, soils need to be limed periodically.

Generally, on sandy loam, loam, and silt loam soils a maintenance application of 2000 to 3000 pounds of lime per acre once every 5 to 7 years is required for legumes and for non-legumes fertilized with nitrogen as recommended. On clay loam and clay soils less frequent but larger applications are required. Although lime may be needed badly on some soils for non-legumes, the deficiency is not widespread enough to warrant a general recommendation for rates in excess of maintenance requirements for these crops in the absence of a soil test. Areas going into permanent grass sod should receive the initial maintenance application of lime prior to establishment. Subsequent maintenance applications may be applied to the surface.

Except for the dark upland soils and the bottom soils of the Northeast Blackland area, maintenance application should be made to soils that have not been limed during the past 5 to 7 years.

The principal liming materials available in Mississippi are ground calcic and dolomitic limestones, crushed chalk or marl from Mississippi deposits and basic slag. Calcic limestones contain calcium carbonate while dolomitic limetones contain both calcium and magnesium carbonates. Liming materials from Mississippi deposits contain calcium carbonate only. Basic slag, a material containing a minimum of 6 percent P_2O_5 and the equivalent of about 75 percent lime should be used only where both the lime and phosphate are needed. The cost for its use as a liming material only is prohibitive.

Research has shown that all of these materials are very effective in neutralizing soil acidity providing the calcic and dolomitic limestones are finely ground. Particles not passing a 40-mesh screen (40 holes per linear inch) are not very effective in neutralizing soil acidity. For this reason 90 to 100% of calcic and dolomitic limestones should pass a 10-mesh screen and 50% a 100-mesh screen. Particle size is not as important in the case of chalk because it contains clay as an impurity which causes the particles to break down within the soil. It must be crushed fine enough, however to be spread uniformly.

Generally, the Delta and Deep Loess soil areas are abundantly supplied with magnesium, therefore dolomitic lime is of no advantage in these areas. In the other soil areas of the state, however, magnesium levels tend to be lower and a liming material containing considerable magnesium, such as dolomitic lime, should be used, particularly in the Northeast Blacklands.

For best results lime should be mixed thoroughly with the top six to eight inches of the soil. However, depending on the texture of the soil, a maintenance application of 1000 to 2000 pounds per acre may be made as a surface application to permanent pastures, or other permanent sods.

Fertilizer Efficiency

The primary objective of using fertilizers is to increase the net profit per acre. The rate of fertilizer required for maximum profit depends upon many factors. Some of the more important ones are: (1) the crop, (2) level of soil fertility, (3) time and method of application of fertilizer, (4) weather, (5) increase in yield from fertilizer, and (6) the ratio of costs to returns from fertilizer. Under a given set of circumstances, the efficiency of utilization of fertilizer by a crop may be greatly affected by time and/or method of application..

Time of Application

In general fertilizer nutrients are reduced in effectiveness following their application to the soil because of loss by volatilization and leaching, and by conversion to less available or to unavailable form within the soil.

Fertilizers may contain nitrogen either in the form of nitrate or ammonium, or both, or in other forms (urea and cyanamide) that are changed rather rapidly to ammonium when applied to the soil. Nitrate salts found in fertilizers and in soils are highly soluble in water. Since they are not retained by combining with the soil, they are easily leached from the root zone, particularly on sandy loam loam, and silt loam soils or other soils where water percolates easily through the soil profile. Under water-logged conditions, particularly in clay soils, nitrates may be changed by soil organisms (denitrification) to gaseous nitrogen which escapes into the atmosphere. Ammonium nitrogen is not denitrified; neither is it easily lost by leaching because it combines chemically with the clay and organic matter. However, it is soon converted by soil bacteria to nitrate salts which may be lost.

Since nitrogenous fertilizers are not retained in soils for long periods, maximum efficiency for crop production is generally obtained by applying them at or near the beginning or during the growing season.

Phosphate fertilizers are not lost from soils by leaching, but their effectiveness for crops is reduced. In acid soils, they react rather rapidly with iron and aluminum to form phosphates that are much less available to plants. These reactions are referred to as "phosphate fixation." Because of this fixation, annual, seasonal applications of phosphate are better than less frequent or off-season application. This is true for both annual and perennial crops. In general, best results are obtained by applying phosphate fertilizers at or just prior to seeding, or near the beginning of the growing period in the case of maintenance applications to perennial crops.

The effectiveness of potassic fertilizers is not reduced appreciably by fixation in Mississippi soil, as is phosphate, nor is it easily leached from soil as nitrate. However, on sandy loam, loam, and silt loam soils the extent of loss by leaching is such that annual, seasonal application are better than less frequent application. Also, excessive uptake (luxury consumption) and removal of the potash in the harvested portion of forage crops makes annual, and sometime split, seasonal applications necessary for optimum efficiency.

Fall or winter plowing to prepare a seed bed is highly desirable, if not essential, for most successful production of row crops on heavy clay soils such as occur in the Blackland Area and the Delta. Where equipment is not available for proper placement of fertilizer in a prepared seed bed in the spring, the phosphate and potash, and magnesium, if recommended, should be applied at the time the seed bed is prepared. The method of application should be such that the location with respect to the seed row will be in conformity with the recommendations for the crop in question. Except for the black clay upland soils and the clay bottom soils of the Northeast Blackland Area or other clay soils known to be slightly acid to alkaline in reaction, the recommended rate of phosphate should be increased by about 50 percent if applied in the fall or winter.

From the foregoing observations it is evident that the soil, fertilizer and crop characteristics must be taken into account in order to time the application of fertilizer so that maximum availability to and need by the crop are made to coincide in so far as it is practical to do so. This is reflected in the recommendations given later.

Method of Application

To obtain maximum efficiency from fertilizers there are two components of availability that must be made optimum concurrently; namely, chemical and positional availability. Chemical availability refers to the capacity of the fertilizer and its soil-reaction products to supply nutrients to plants. Positional availability refers to the location of the fertilizer with respect to the plant roots. For example, fertilizer placed in the soil a foot or so from the row is positionally unavailable to seedling plants.

The chemical availability of nitrogen and potassium in fertilizers usually is not affected greatly by degree of contact with the soil. However, the effectiveness of highly reactive phosphates is improved by reducing their contact with the soil because the rate of phosphate fixation is reduced. This is done either by band placement in the soil or by granulation of the fertilizer at the factory. Since most solid fertilizers sold in Mississippi are granulated, or pelletized, the effect of method of application on positional rather than chemical availability is of major significance.

To provide the most effective positional availability, fertilizers should be placed so as to be intercepted by plants roots at an appropriate time, or be moved to plant roots with soil water. As plants grow and extend their roots both horizontally and vertically the volume of soil from which nutrients may be absorbed is increased. Therefore, fertilizers placed so as to be positionally unavailable during early plant growth may become available later.

Phosphate does not move appreciably in soils and the movement of potash is somewhat limited, especially on soils of medium to fine texture. Therefore, these fertilizers must be placed so as to be intercepted by plant roots. For drill-seeded and row crops they should be placed in the soil deep enough to be in moist soil where plants feed during the growing season. For such crops surface application or shallow incorporation, as by disking, would be expected to give inferior results because of poor positional availability. Nitrogenous fertilizers applied to the surface of the soil, particularly when dry, remain positionally unavailable for the most part until dissolved and moved down into the root zone by percolating water. Before the ammonium form of the nitrogen in fertilizers is moved down into the root zone, it must be changed (nitrified) by soil bacteria to the nitrate form, a process requiring two or more weeks for completion in moist soil during warm seasons. By applying nitrogenous fertilizers far enough in advance for the necessary transformations and movement into the root zone by rainfall to occur by the time the nitrogen is needed by the crop, unfavorable positional availability is avoided.

Localized concentration of immobile fertilizers nutrients, such as phosphorus and potassium, near the row or drill, as by band application, provides the most favorable opportunity for early interception by plant roots as well as for extensive root development within the fertilized zone later, a condition which contributes to optimum fertilizer efficiency. An outstanding benefit from phosphorus is its favorable influence on the early and growth development of plants which also is enhanced by localized placement near the row.

Since nitrogen as nitrate does move with the soil water to plant roots, its over-all efficiency is not affected greatly by degree of concentration or its location within the root zone except that enough nitrogen should be positionally available for optimum growth of young plants.

Although maximum efficiency of phosphate and potash are usually obtained by band placement on row crops and drill-seeded crops, top yields can be obtained by broadcasting and mixing the fertilizer with the soil. However, because of reduced efficiency, especially where these fertilizers are applied to the surface and disked in rather than being plowed down, the rate of application should be 30 to 50 percent higher than recommended for band application.

A hazard of localized placement of the fertilizers near the row is salt injury to seeds and seedlings resulting in poor stands and stunted growth. Since fertilizer salts, such as nitrates and chlorides, move mostly upward and downward with soil water rather than laterally by difussion, salt injury can be avoided by placing the fertilizer to the side of rather than beneath the seed. The distance of separation required depends upon the kind of fertilizer and the rate of application. For recommended rates of phosphate and potash and up to 40 pounds of nitrogen per acre, the minumum distance of separation should be 2 to 3 inches to the side of and 2 to 3 inches below the seed. With higher rates of nitrogen or potash both the horizontal and vertical distances between seed and fertilizer should be increased.

Surface application of phosphate and potash to sod crops is more effective than for row crops except during periods of drought. This is because of the development and persistence of plant roots near the surface; in fact, this method is so effective that it is recommended for making maintenance applications of fertilizers to perennial close-growing crops. Solid sources of nitrogen are much more effective for surface application to pastures than are the urea-ammonium nitrate solutions, such as N-Sol-32 and Uran. Thus far, these solutions have ranged in effectiveness from 55 to 75 percent of that of solid ammonium nitrate.

Foliar Feeding

Plants absorb and utilize nutrients applied in solution to their leaves and if a deficiency exists, yields and/or quality may be improved by foliar application. Because they are required in such small amounts, very dilute nutrient salt solutions of the micronutrients (trace elements) may be used quite satisfactorily as foliar sprays to correct deficiencies without injury (burning) to foliage. In some areas foliar feeding of trace elements has become a somewhat standard practice for crop production. Frequently, micro-nutrients are applied conveniently and inexpensively along with insecticides and fungicides. A typical example is the application of boron to cotton with the insecticide. However, so far, under Mississippi conditions there appears to be no need for both foliar and soil application of micronutrients where they are needed for crop production.

The primary (nitrogen, phosphorus, and potassium) and secondary (sulfur, calcium, and magnesium) nutrients, are absorbed in relatively large quantities by crops. Thus, to supply a substantial part of the total requirement of these nutrients without burning the leaves of plants would require several applications of rather dilute solutions during the growing season. Therefore, foliar feeding of these nutrients is not as feasible as foliar feeding of the micronutrients. Increases in the yield of cotton have been obtained in Mississippi under certain conditions from foliar feeding of the primary nutrients, but it has not been shown so far to be a desirable or economical alternative to soil application of these nutrients. Therefore, foliar feeding is not now recommended routinely in lieu of or as a supplement to soil application of the primary and secondary plant nutrients.

Recommendations for Major Field Crops

CORN

Hybrids are listed in descending order of yield based on three-year averages. For detailed comparison consult the January 1967 issue of Mississippi Farm Research.

Area 1, Northeast Mississippi:

White: Dixie 55, Funk G-795 W-1, Dixie 77, Embro Departure VIII.

Yellow: Dekalb 1006, Dixie 22, *McCurdy M97, *Pioneer 309B, *Embro Jarvis E, Funk G-711 AA, Funk G-707, Embro 222 T A, *Funk G-4703.

Area 2, Delta and Foothills:

White: Dixie 55, Funk G-795 W-1, Dixie 77.

Yellow: *Embro Jarvis E, Funk G-732, *DeKalb 1213, DeKalb 1006, Funk G-711 AA, *McCurdy M97, *Pioneer 309 B, *Coker 67, Embro 222 T A, Dixie 22, *Funk G-4703, Funk G-707.

Area 3, North Central Mississippi:

White: Funk G-795W-1, Dixie 55.

Yellow: Funk G-720, Funk G-732, Pioneer 3048, Funk G-711 AA, McCurdy M306, *Dixie 82, Dekalb 1006, *DeKalb 1213, Embro Jarvis L, Dixie 22, Funk G-707.

Area 4, South Central Mississippi:

White: Funk G-795W-1, Dixie 55, *Coker 811 A.

Yellow: McCurdy M306, Dixie 22, DeKalb 1213, Funk G-732, Dixie 18, *Dixie 82, Funk G-745 A, Embro 260, *Coker 71, *Coker 67, Embro Jarvis L.

Area 5, South Mississippi:

White: Funk G-795W-1, Dixie 55, Coker 811A.

Yellow: *Coker 67, *Coker 71, McCurdy M306, *DeKalb 1213, *Pioneer 3048, Funk G-732, Funk G-740, Funk G-745A, Embro Jarvis 260, Dixie 18.

*More susceptible to the corn "stunt" virus than other recommended hybrids.

Corn for Silage: Select a recommended variety having high grain yield and lodging resistance. Space plants 10-12 inches apart.

Seeding Rates and Dates and Land Selection: Plant in South Mississippi from March 10 to April 10, in Central Mississippi from April 1 to April 20, and in North Mississippi from April 5 to April 20. Corn should be planted on deep to moderately deep soils with fair to good surface drainage. Steep, droughty, and eroded hillsides should be avoided. Depending upon the crop yield that can be obtained, plants should be spaced in the row to give population ranging from 10,000 to 14,000 per acre. To obtain these plant population, planting rates of 11,500 to 16,500 kernels per acre usually are required. A stand that is properly adjusted with yield should provide 100-120 plants per bushel of corn. These stands correspond to yields of 80 to 140 bushels per acre. As a rule, stands should not exceed 12,000 plants per acre except on soils, or where irrigated. On most upland the most highly productive bottomland soils stands should be approximately 10,000 plants per acre.

Fertilization—Hill and Delta Foothill Areas: Soils of the Hill and Delta-Foothill Areas generally require a complete fertilizer for corn. Occasionally, following the application of lime, zinc deficiency may be encountered, especially on soils of medium to coarse texture. When this occurs, a mixed fertilizer containing zinc should be used. No other micronutrient deficiencies have been observed in corn.

Time: Apply all of the phosphate and potash before planting. Nitrogen maybe applied before planting or in split applications. As a rule it is advantageous to apply two-thirds or more of the nitrogen as a side-dressing. The side-dressing should be made by the time the corn is knee high.

Rate: Apply 40 to 50 pounds each of phosphate (P_2O_5) and potash (K_2O) and, depending upon the stand, 130 to 200 pounds of nitrogen per acre. To adjust nitrogen rate to the stand apply 1.3 pounds of N per 100 plants for plant populations of 10 to 12 thousand and 1.4 pounds of N per 100 plants for populations of 12 to 14 thousand. If corn is to be grown continuously for silage on the same field for several years, apply 50 to 60 pounds of phosphate and 96 to 120 pounds of potash per acre in a 1:2 ratio.

Method: Apply the phosphate and potash and up to 60 pounds of nitrogen in a narrow band 2 to 3 inches to the side and 2 to 3 inches below the seed. With higher rates of nitrogen both the vertical and horizontal separation of seed and fertilizer should be increased by 1 to 2 inches. Preplant application of anhydrous ammonia should be placed 5 to 6 inches to the side and 6 inches deeper than the seed.

Side-dress applications of nitrogen should be placed a foot or more from row, non-pressure solutions and solid sources at a depth of 3 to 5 inches and anhydrous ammonia at a depth of 6 inches.

Fertilization—Delta Area: For soils in this area, only nitrogen is needed generally for top production. Soil test for phosphate and potash needs.

Time: Nitrogen may be applied just prior to planting or in split application: one-half at or before planting and the rest as a side-dressing before the corn is knee high.

Rate: 130 to 200 pounds of nitrogen per acre. To adjust the nitrogen rate with stand apply about 1.3 to 1.4 pounds of nitrogen per acre for each 100 plants as indicated for Hill Area.

Method: Place preplant applications of nitrogen 4 to 6 inches from the drill row, non-pressure solutions and solid sources at a depth of 4 or more inches and anhydrous ammonia at a depth of 6 inches below the level of the seed. Side-dress applications of nitrogen should be placed 1 foot or more from the row, non-pressure solution and solid at a depth of 4 inches and anhydrous ammonia at a depth of 6 inches.

COTTON IN THE DELTA

Varieties: Stoneville 213, Deltapine 15A, Stoneville 7A, Deltapine 45A, Carolina Queen, and Deltapine Smooth Leaf.

Seeding Dates and Rates: Plant as soon after April 1, as weather permits, but not in cold soil. Hill dropped—16 to 22 pounds of delinted seed per acre. Drilled—30 to 40 pounds of delinted seed per acre. Drilled for cross plowing—60 pounds of delinted seed per acre. Seed should be of good viability.

Fertilization: Delta soils generally need only nitrogen fertilizer for most profitable yields, but in the Foothills area and sometimes elsewhere the use of phosphate and potash may be profitable. Therefore, soils should be tested for phosphate and potash needs. Soils should be limed according to soil tests to maintain the pH above 5.5.

Time: Apply nitrogen in the spring at or prior to planting, except on sandy loam soils having very good to excessive internal drainage and on clayey soils with poor surface drainage. On such soils, split application of nitrogen should be made, one-half at or prior to planting and the rest as a side dressing preferably by mid-June. Split application of nitrogen on clays with poor surface drainage is recommended because of possible loss of nitrogen by denitrification during wet periods.

Rate: On sandy loam, loam, and silt loam soils rates from 90 to 100 pounds of nitrogen per acre are recommended for solid planted cotton and for all skip-row patterns. 100 to 120 pounds of nitrogen per acre is recommended for the silty clay loam, silty clay, and clays regardless of the planting pattern, except that for clays with poor surface drainage the rate should be 120 to 150 pounds of nitrogen per acre.

For cotton following soybeans or pasture sod, the nitrogen rate should not exceed 60 pounds per acre, especially following pasture sod.

The nitrogen rate should be reduced to 75 pounds per acre on soils where stalk growth is too rank, maturity too late, and boll rot is a problem. If there is evidence of deficiency, the rate should be increased 30 percent.

All nitrogen fertilizer recommendations are on the basis of a planted acre regardless of the planting pattern, this is. whether skiprow or solid.

COTTON IN HILL AREAS

Varieties: Stoneville 213, Carolina Queen, Stoneville 7A, DeKalb 220, Empire WR61, Deltapine Smooth Leaf, and Auburn 56.

Fusarium wilt resistant; Auburn 56, Carolina Queen, Empire WR61, Dixie King 11, Rex Smoothleaf, and DeKalb 108.

Venticillium wilt tolerant; Auburn 56, Stoneville 7A and 213, and Rex Smoothleaf.

Seeding Dates and Rates: Plant between April 10 and May 10 as weather permits. Hill dropped—16 to 22 pounds of delinted seed per acre. Drilled—20 to 30 pounds of delinted seed per acre. For undelinted seed increase rates by 10 to 15 pounds per acre. Seed should be of good quality.

Fertilization: A complete fertilizer (NPK) containing sulfur and boron is needed in the Hill Sections. Fertilizers for the dark upland soils of the Northeast Blackland Area having a pH above 6.0 should contain enough water-soluble magnesium to supply at least one-half and preferably as much magnesia (MgO) as potash. On soils more acid than pH 6.0 magnesium deficiency may be corrected by applying dolomitic lime at the rate of one to two tons per acre, or as indicated by a soil test, to supply magnesium.

Enough boron is provided when the mixed fertilizer contains boron and phosphate in the proportion of 0.3 pounds to 48, respectively, or a boron to phosphate ratio of 1:160. No more than 0.5 pounds of water-soluble boron should be drilled with the fertilizer close to the seed.

Acid soils should be limed according to soil tests to maintain the pH above 5.5.

Time: Apply the phosphate and potash and all or part of the nitrogen at or a few weeks before planting time. On deep sandy or sandy loam soils with very good to excessive internal drainage, side dress one-half to two-thirds of the nitrogen for most effective results. Make side-dress applications of nitrogen by mid-June (a week or more earlier if anhydrous ammonia is used), or at early square formation.

Phosphate and potash may be applied in the fall to certain clay soils of the Blackland Area with good results—see section on Fertilizer Efficiency.

Rate: Apply 72 pounds of nitrogen (N) and 48 pounds each of phosphate (P_2O_5) and potash (K_2O) per acre except as follows: Increase the nitrogen to 110 pounds and phosphate and potash to 60 pounds each per acre on the dark upland soils of the Blackland Areas; increase the nitrogen to 90 pounds per acre on the well-drained bottom and bench-land soils of the Upper Coastal Plain and Blackland Areas.

Where a skip row planting pattern is followed the rate of nitrogen per planted acre should be the same as is recommended for solid cotton but the rate of phosphate and potash should be increased to 60 pounds of each per acre where a lower rate is recommended for solid cotton. In a 4 x 4 or 2 x 2 planting pattern there is, of course, only one-half acre of planted cotton. Fertilizer should not be applied to skipped rows.

The nitrogen rate should be reduced by about 30 percent where stalk growth is too rank, maturity too late, or boll rot is a problem; it should be increased by about 30 percent if there is evidence of nitrogen deficiency such as stunted growth with yellowish-green foliage or the general development of yellow foliage too early in the fruiting period.

Method: Place fertilizers in narrow bands 2 to 4 inches to the side of and 2 to 4 inches below the cotton seed. If all of the nitrogen is applied with the phosphate and potash in a single band at or prior to planting the maximum separation recommended should be employed. Contact placement of seed and fertilizer as well as very shallow placement beneath the seed should be avoided. Place anhydrous ammonia 4 to 6 inches to the side of and 4 to 6 inches deeper than the seed. Where weeds and grass are not a problem, broadcasting solid or non-pressure nitrogen solutions followed by shallow surface incorporation is a satisfactory method of application at planting time except, perhaps, on clay soils. Place side-dress applications of nitrogen a foot of more from the row, non-pressure solutions and solids at a depth of 3 to 5 inches and anhydrous ammonia at a depth of 6 inches. Surface, side-dress application of solid sources such as ammonium nitrate, nitrate of soda and ammonium sulfate usually is as effective as placement in the soil if application is made a week or so earlier so that the nitrogen may be washed into the root zone by the time it is needed by the crop.

RICE IN THE DELTA

Varieties: Long grain: Bluebonnet 50 maturing in 150 days, Dawn maturing 130 days and Bluebelle maturing in 115 days. Medium grain: Saturn, Nato and Nova maturing in 125 - 130 days.

Seeding Dates and Rates: Rice can be seeded from mid-April to mid-June depending upon variety. The very early varieties should not be planted until June. Seeding rate 90 to 110 pounds if drilled and 110 to 135 pounds if broadcast or water seeded.

Fertilization: Apply from 80 to 120 pounds of nitrogen per acre on old crop land. New land will probably require no nitrogen for the first two years. The ammonium forms of nitrogen such as ammonium sulfate and urea are recommended. Fertilizer may be applied before seeding if covered by approximately 2 inches of soil. Otherwise, it may be applied just before the first flood or one-half before the first flood and one-half at 45, 55, and 65 days after emergence for the 115, 130, and 150 day varieties, respectively. When all the nitrogen is applied in the water the rates should be increased 20 percent.

SOYBEANS

Varieties: Delta Area — Hill, Hood, Lee, Semmes, and Bragg (listed in order of maturity).

Hill Section: North; Hill, Hood, Lee and Bragg. South; Hampton and Bragg; Hardee in extreme south.

Soils: Soybeans are adapted to all Delta soils and to most soils of the Hill area, but lower yields may be expected on droughty soils such as eroded and shallow upland soils.

Seeding Dates and Rates: May 1 to June 15 except extreme South Mississippi June 1 to June 20. Plant 40-50 pounds of good seed per acre.

Inoculation: If not on land where a crop of well nodulated soybeans has grown within the last five years, the seed should be innoculated.

Fertilization—Delta Area: Soybeans require no fertilizer on most Delta soils but a high percentage need lime. A soil test will indicate the need for lime as well as phosphate and potash.

Fertilization—Hill Area: In the Hill Area, phosphate and potash as well as lime usually are needed. Except for the dark soils of the Blackland Area of Northeast Mississippi, some 70 percent of the soils of the Hill Area need lime for top yield. In the absence of a soil test, apply both phosphate (P_2O_5) and potash (K_2O) at the rate of 40 pounds per acre in a band 2 to 4 inches to the side and 2 to 4 inches below the seed. Avoid contact placement with the seed as well as band placement directly beneath the seed. Much new land, as well as land in unfertilized pastures, is extremely deficient in phosphorus and the rate indicated above probably will not be adequate for top, profitable yields if planted to soybeans. On such land the phosphate should be increased to 60 to 80 pounds per acre for a few years by using a mixed fertilizer of 0-4-3 or 0-2-1 ratio. If fertilizers are applied broadcast increase the rate by about 30 percent.

In some parts of the state double cropping of small grain and soybeans may be practiced. In such a system it would be satisfactory to apply all of the phosphate and potash recommended for both crops to the small grain.

Molybdenum is a trace element required by plants and the nodule bacteria of legumes. A seed treatment with molybdenum at the rate of ¼ oz. of sodium molybdate per acre or its equivalent has increased yield of soybeans in the Hill Areas about 7 bushels per acre on strongly to very strongly acid soils and about 2 bushels per acre on soils that do not need lime, pH 6.0 or above. Decreasing response to molybdenum with increasing pH, or lime content, occurs because the native soil molybdenum becomes more available. Based on results so far, it appears that a seed treatment with molybdenum may be needed for top yields regardless of the lime status of the soil. Certainly, it is needed if the soil is not known to have a pH of 6.0 or above.

SORGHUMS FOR GRAIN, SILAGE

Varieties for Grain: AKS 614; DeKalb's C44B, E57, BR60, BR62, and F64; GA 615; Lindsey 555; NK227; P.A.G. 515S; Ranger B; RS 610; Savannah; and TE66.

The above varieties may also be used for silage, especially when grown for high producing milk cows. Where higher yields per acre but with somewhat lower quality are desired, the varieties listed for silage (below) should be used.

Varieties for Silage: FS1A, NK300, 101 F.

Seeding Dates and Rates: April 20 to July 15. Earlier dates are preferred. If first harvest is made by July 25, a second cutting can usually be made if soil moisture is adequate.

Rates for Grain — Seed 6 to 9 lbs. of seed per acre in 38" to 40" rows; for silage use 4 to 6 lbs. per acre in 38" to 40" rows.

Fertilization—

For Grain: In Delta apply 90 to 120 lbs. of nitrogen only.

In Hill section apply 80 to 120 lbs. of nitrogen at seeding along with 30 to 40 lbs. of P_2O_5 and 30 to 40 lbs. of K_2O. Where a second cutting is desired apply an additional 40 to 60 lbs. of nitrogen after the first cutting.

For Silage: Apply as for grain, except double the rate of potash.

SUGARCANE FOR SIRUP

Varieties: C. P. 36-111. On deep, well drained soils of light texture.

Seeding Dates and Rates: Cut seed cane at the top mature joint and at ground level, but do not strip before planting. Plant in the Fall (October 15) at the rate of 2 stalks, that is, place stalks end to end with a whole stalk at the union. Plant the cane in 4-foot rows on land that has been broken 5 to 6 inches deep a few weeks earlier. To protect from cold and to provide good drainage, cover the cane 6 to 8 inches deep by forming a ridge over it so that the drainage furrows between the rows are 2 to 4 inches deeper than the cane.

Fertilization: In the spring apply 40 to 50 pounds each of nitrogen and phosphate (P_2O_5) and potash (K_2O) per acre shortly after germination of the eyes or just before re-growth from stubble. Place the fertilizer in a band so that it will be 4 to 6 inches to the side of the row and 3 to 5 inches deep after the ridges have been worked down, or 1 to 2 inches deeper than the cane. Side-dress with about 30 pounds of nitrogen per acre before July. Place side-dressing nitrogen in the edge of the root zone deep enough to be in moist soil without being disturbed by subsequent cultivation.

Strip, top, and cut the cane before freezing weather. Harvesting as much as a month before processing improves sirup quality and reduces "sugaring."

Grasses, Legumes, and Small Grains

(See Tables on pages 18-24)

Supplementary Information on Pasture Recommendations for the Hill Section

If equipment is available, drill or band placement of seed and fertilizer is recommended for the establishment of all pasture and forage crops. With small-seeded legumes and grasses, care must be taken not to seed too deep. A seeding depth no more than ½" is recommended. Most plantings are made by broadcasting the seeds on the soil surface. In which case the area planted should be cultipacked immediately before or after seeding.

For established pastures, solid and liquid complete fertilizers and solid sources of nitrogen may be top-dressed. On summer grass pastures, however, the efficiency of top-dressed urea-ammonium nitrate (non-pressure) solutions has been quite low compared to solid ammonium nitrate.

Where conditions are especially favorable for legumes, the danger of bloat may prevent full utilization of legumes seeded alone or of grass-legume combinations such as Dallisgrass and white clover, particularly in the Deep Loess area. The drilling of small grains or ryegrass into such a pasture will lessen the bloat problem and supply additional forage. In North Mississippi, orchardgrass may be seeded to help reduce bloat in clover pastures.

Because of the wide variety of soils to which these pasture recommendations will be applied, and of the extensive nature of the typical commercial livestock operation in Mississippi, particularly beef cattle, the pasture fertilizer recommendations (Tables on pages 18 to 23) are generally presented as a range instead of a single and more arbitrary figure.

The lower limit of the recommendation is estimated to be sufficient for plant establishment and (1) for reasonable yields of forage on soils well adapted to the particular pasture crop under consideration, (2) for periods of economic stress during which it is still necessary to maintain a reasonable supply of cheap forage, and (3) where acreage per animal unit is not a serious limiting factor.

The upper limit of the fertilizer recommendations continues to be the agronomic optimum and should be used where the (1) soil type, (2) management system, (3) type of livestock enterprise, and (4) economic trend are such as to justify the considerably higher yields of forage that result from its use.

For winter growing grass-legume combinations, the amount of nitrogen used and the time of appplication depend primarily upon when grazing is needed and upon the desired proportion of grass and legume. Although there is very little difference in the total season's production of forage, fall applications speed plant establishment, increase fall and winter yields, and tend to provide a more favorable grass-legume ratio. For milking cows, lambs and other classes of livestock or system of managements where fall and winter grazing is important, and where danger of bloat exists, application of 30-60 lbs. N at planting time is recommended.

The yield of grass forages is greatly increased by application of nitrogen and, where weather conditions do not limit growth, excellent response is obtained to high rates of nitrogen; therefore, the most economical rate will depend upon temperature, availability of moisture, and the use made of the additional forage.

To increase the utilization of the nitrogen or to obtain a more favorable distribution of pasture production, split applications of nitrogen are recommended for both summer and winter grass pastures, with 60-120 pounds being applied each time. Except for coastal bermudagrass, where the last application may be as late as September 1, the last application of nitrogen to permanent summer pastures should be made no later than August 1, and two weeks earlier if anhydrous ammonia is used. Because of the frequency of drought, mid-summer applications of nitrogen are generally less effective than applications made in the spring and early summer. For this reason more nitrogen should be applied in the spring than in summer season.

It may be economical to apply up to 200 pounds of nitrogen per acre to millet and sudangrass; 200 pounds to common Bermudagrass, Dallisgrass, and Bahiagrass, and 240 pounds to Coastal Bermudagrass pasture.

For summer temporary grazing crops, best response is obtained from nitrogen incorporated into the seedbed with phosphorus and potash prior to planting. Surface applications after each grazing or cutting are effective if rainfall is adequate.

For winter growing grass or grass-legume pastures that are seeded late and from which no fall or winter grazing can be expected the nitrogen application should not exceed 60 lbs. at seeding.

Fall application of phosphorus or potash to pastures is recommended if these nutrients are necessary to establish forage seedlings in the fall. However, spring application is slightly more effective for spring and summer growth of perennial plants and those which come up in the spring. In general, fertilizers should be applied as close as practical to the time they are to be used by plants.

Recommendations for Pastures in Hill Sections

Pasture Crop	Recommended Varieties	Time of Planting	Rate of Seeding per Acre	Fertilization, lbs./A Annual Application[1]
		WARM SEASON GRASSES (PERMANENT)		
Bahiagress	Pensacola, Wilmington, (Argentine—South Mississippi only)	Feb.-April; or Aug.-Oct.	15 lbs./A	120 to 180 lbs. N in split applications and 30 to 45 lbs. each of P_2O_5 and K_2O. Total application in a 4-1-1 ratio.
Bermudagrass	Common	Feb.-May	3-5 lbs. seed	Same as for Bahiagress.
	Coastal	Feb.-May	20 bu. of sprigs per acre	**For Grazing:** 120 to 240 lbs. N in split applications and 30 to 60 lbs. each of P_2O_5 and K_2O. Total application in 4-1-1 ratio. **For Hay:** 200 to 300 lbs. N in split applications; 50 to 90 lbs. of P_2O_5; 100 to 180 lbs. K_2O. Total application in a 4-1-2 ratio.
Dallisgrass	Domestic, imported	Feb.-April; Aug.-Oct.	10 lbs. (live seed)	Same as Bahiagrass.
Johnsongrass	Commercial	Feb.-May	15-25 lbs. (live seed)	Same as for Coastal bermuda grass.
		COOL SEASON GRASSES (PERMANENT)		
Tall Fescue	Kentucky-31, Kenwell, Alta	Aug.-Oct. 15	15 lbs.	80 to 140 lbs. N, split—fall and spring; 40 to 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio.
Orchardgrass (North Miss. only)	Commercial	Aug.-Oct. 15	15 lbs.	Same as Tall Fescue.

WARM SEASON GRASS - LEGUME MIXTURES (PERMANENT)

Bahiagrass, Bermudagrass, Dallisgrass with one of the following legumes:		As above	As above	**Establishment:** 60 to 100 lbs. of P_2O_5 and 30 to 50 lbs. K_2O in a 2:1 ratio.
White Clover	Regal, La. S-1, or Tillman	Sept. 1-Oct. 15	1-3 lbs.	**Maintenance:** 40 to 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio
Crimson Clover	Chief, Autauga or Frontier	Sept. 1-Oct. 15	25 lbs.	Same as above. For seed production add 0.5 to 1 lb. of boron.
Arrowleaf	Meechee	Sept. 1-Oct. 15	5-8 lbs.	Same as Crimson Clover.
Lespedeza	Kobe, Climax, or Summit	Feb.-April	20 lbs.	**Establishment:** 40-60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. **Maintenance:** 40 lbs. each of P_2O_5 and K_2O.
Johnsongrass with one of the following for hay:	Commercial	Feb.-May	15-25 lbs. (live seed)	
Alfalfa	Delta, Cody, Cherokee		15 lbs.	**Establishment:** 100 to 150 lbs each of P_2O_5 and K_2O in a 1:1 ratio. **Maintenance:** 60 to 80 lbs. P_2O_5 and 180 to 240 lbs. K_2O in a 1:3 ratio.
Red Clover	Orbit		10 lbs.	Same as with Alfalfa.
Wild Winter Peas	Commercial		30 lbs	60 to 90 lbs. P_2O_5 and 120 to 180 lbs. K_2O in a 1:2 ratio, 120 lbs. N after peas mature.

Recommendations For Pastures In Hill Sections—(Continued)

Pasture Crop	Recommended Varieties	Time of Planting	Seeding per Acre	Fertilization, lbs./A annual Application[1]
WARM SEASON GRASSES (ANNUAL OR TEMPORARY)				
Millet	Gahi-1, Starr	Apr. 15-June 15	10 lbs. in rows 25 lbs. broadcast	120 lbs. N, split application, 60 lbs. P_2O_5 and 60 lbs. K_2O.
Sorghum-Sudan hybrids	Grazer-A, Haygrazer, Lindsey 77--F, MorSu, Sordan, Sweet Sioux, SX-12	Apr. 15-June 15	15 lbs. in rows 25 lbs. broadcast	120 to 180 lbs. N in split applications; 60 lbs. P_2O_5 and 60 lbs. K_2O.
COOL SEASON GRASS - LEGUME MIXTURES (ANNUAL OR TEMPORARY)				
Annual Ryegrass with one of the following:	Gulf, Magnolia or Tetrablend		25 lbs.	0-30 lbs. N, 60-100 lbs. P_2O_5, and 30 to 50 lbs. K_2O in a 2:1 ratio.
Arrowleaf Clover	Meechee		6 lbs.	
Crimson Clover	Autauga, Chief, Frontier		20 lbs.	Same as above.
Annual Ryegrass and wheat or oats with legume (as with ryegrass)	As above See wheat and oats		15 lbs. 90 lbs.	Same as above.
Small Grains and Legume (Use same as with ryegrass)	Oats, rye or wheat (See varieties under grasses)		90 lbs. of small grain	Same as above.

COOL SEASON GRASS - LEGUME MIXTURES (PERMANENT)

Tall Fescue or	Alta, Kentucky-31, Kenwell	Sept. 1-Oct. 15	10 lbs.	**Establishment:** 60 to 100 lbs. of P_2O_5 and 30 to 50 lbs. of K_2O in a 2:1 ratio. **Maintenance:** 40 to 60 lbs. of P_2O_5 and K_2O in a 1:1 ratio.
Orchardgrass (North Mississippi only)	Commercial	Sept. 1-Oct. 15	10 lbs.	
with				
White Clover	Regal, Tillman, or La. S-1	Sept. 1-Oct. 15	1-3 lbs.	

COOL SEASON GRASSES (ANNUAL OR TEMPORARY)

Annual Ryegrass	Gulf, Magnolia, Tetrablend	Sept. 1-Oct. 15	20-30 lbs.	120 to 220 lbs. of N, split fall and spring; 80 to 100 lbs. P_2O_5 and 40 to 50 lbs. K_2O in a 2:1 ratio.
Rescuegrass	Lamont	Sept. 1-Oct. 15	30-40 lbs.	Same as Ryegrass.
Barley (Grain only)	Dayton, Harrison, Kenbar, and Decatur	Oct. 1-Nov. 15	1½ bu.	10 lbs. N at planting, 20 lbs. P_2O_5 and 20 lbs. K_2O at seeding. Topdress with 40 to 60 lbs. N about March 1.
Oats	Sumter, Midsouth, Moregrain, Delair	For Forage: Sept. 1-Oct. 1 For Grain: Oct. 1-Nov. 15	For Forage: 128 lbs. (4 bu.) For Grain: 2½ bu.	Same as Ryegress. Same as for Barley.
Rye	Elbon, Explorer	Same as Oats	For Forage: 90 lbs. For Grain: 2½ bu.	Same as Ryegress. Same as for Barley.
Wheat	Knox, Ace, Coastal, Georgia 1123, Vermillion, Knox 62, Coker 6119, Bledsoe, Wakeland	Same as for Oats	For Forage: 90 lbs. For Grain: 1¼ bu.	Same as Ryegress. Same as for Barley.

Recommendations for Pastures in Hill Sections—(Continued)

Pasture Crop	Recommended Varieties	Time of Planting	Seeding per Acre	Fertilization, lbs./A Annual Application[1]
		LEGUMES		
Alfalfa (Hay)	Delta, Cherokee, Cody	Aug. 15-Oct. 15	15-25 lbs.	**Establishment:** 100 to 150 lbs. each of P_2O_5 and K_2O in a 1:1 ratio and 10 lbs. boron. **Maintenance:** 60-80 lbs. P_2O_5 and 180 to 240 lbs. K_2O in a 1:3 ratio and add 1 lb. boron.
Arrowleaf Clover	Meechee	Sept.-Oct. 15	10 lbs.	40 to 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. For seed production add 0.5 to 1.0 lb. boron.
Austrian Winter Peas	Commercial	Sept.-Oct. 15	50 lbs.	Same as for Arrowleaf Clover.
Crimson Clover	Autauga, Chief, Frontier	Sept.-Oct. 15	20-30 lbs.	Same as for Arrowleaf Clover.
Lespedeza (Annual) Sericea (Perennial)	Climax, Kobe, Summit Serella, Commercial	Feb.April 15 Feb.-June	25 lbs. 30-40 lbs.	Same as for Arrowleaf Clover.
Red Clover (Hay)	Orbit	Sept. 1-Aug. 15 Mar.-Apr. 15	10 lbs.	**Establishment:** 60 to 100 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. **Maintenance:** 30 to 50 lbs. P_2O_5 and 60 to 100 lbs. K_2O in a 1:2 ratio.
Rough Pea	Commercial—also known as Singletary, Caley and Wild Winter Peas	Sept. 1-Oct. 15	40 lbs.	Same as for Arrowleaf Clover.

Vetch	Warrior	Sept. 1-Oct. 15	30 lbs.	Same as for Arrowleaf Clover.
White Clover	La. S-1, Regal, Tillman	Sept. 1-Oct. 15	2-3 lbs.	Same as for Arrowleaf Clover.

[1] For legumes and grass-legume combinations, soils should be limed initially to establish and subsequently to maintain a pH of 6.0 to 7.0; for non-legumes the pH range should be 5.5 to 6.5 Refer to section on Soil pH and Liming. Unless indicated otherwise fertilizer recommendations are for grazing. When forage and pasture crops are harvested repeatedly from the same area for hay or silage instead of being grazed, the rate of potash should be increased to about twice that recommended for grazing.

Recommendations for Lawns and Similar Turf Areas

Grass	Recommended Varieties	Method of Planting	Rate of Planting	Fertilization per 1000 sq. ft. per Yr.
Bermudagrass	Common Tiflawn, Ormond, Tifway, Tifdwarf, Tex-turf 10	Seed Sprig or plug	2 lbs./1000 sq. ft. Sprig or plug 6-12 ins. apart on 6-12 in. rows	6-8 lbs. nitrogen 3 lbs. P_2O_5 3-4 lbs. K_2O, split into 4 applications
Zoysiagrass	Emerald, Matrella, Meyer	Sprig or plug	Sprig or plug 6 ins. apart on 6 in. rows	5-6 lbs. nitrogen 2-3 lbs. P_2O_5 3-4 lbs. K_2O, split into 4 applications
St. Augustine	Common	Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows	Same as zoysia
Centipede	Common, Oklawn	Seed Sprig or plug	4 oz./1000 sq. ft. Sprig or plug 6-12 ins. apart on 6-12 in. rows	2-3 lbs. nitrogen 1-2 lbs. P_2O_5 1-2 lbs. K_2O, split into 2-3 applications
Carpet	Common	Seed	5 lb./1000 sq. ft.	Same as centipede
Bahia	Argentine, Pensacola, Paraguayan, Wilmington	Seed	5 lb./1000 sq. ft.	Same as zoysia
Annual Ryegrass	Gulf, Magnolia	Overseed	8-10 lb./1000 sq. ft.	1 lb. nitrogen in January if needed

Recommendations for Delta Pasture and Grain Crops

Pasture Crop	Recommended Varieties	Rate of Seeding Per Acre	Time of Planting	Fertilization, lbs./A. Annual Application, Except Lime.
Alfalfa	Buffalo and Delta	10-20 lbs.	Sept. 1-Oct. 15	Test soil for lime, phosphorus and potash needs.
Bermudagrass	Coastal (Irrigated)	20 bu. sprig	Nov. 1-May 1	180 lbs. N, 4 applications beginning June 1 for grazing. For hay, 300 lbs. N in split applications.
Bermudagrass-Clover	Clover, La. S-1	2 lbs.	Plant Clover Sept. 1-Oct. 15	Test soil for lime, phosphorus and potash needs.
Fescue and Clover	Kentucky-31 Fescue La. S-1 White Clover	10 lbs. Fescue 1-2 lbs. Clover	Oct. 1-Nov. 1 Feb. 1-May 1	30 lbs. N at planting, 60 lbs. N Sept. 1 for winter grazing. Test soil for lime, phosphate and potash needs.
Red Clover	Orbit, Kenland	10-15 lbs. seed alone or in small grains	Oct. 1-Nov. 1	Test soil for lime, phosphate, and potash.
White Clover	La. S-1	2-3 lbs. seed with grass	Oct. 1-Nov. 1	Test soil for lime, phosphate, and potash.
Arrowleaf Clover	Meechee	12-15 lbs.	Oct. 1-Nov. 1	Test soil for lime, phosphate, and potash.
Sorghum-Sudan hybrids	Grazer-A, Haygrazer, Lindsey 77-F, MorSu, Sordan, Sweet Sioux, SX-12	10 lbs. in rows	Apr. 15-June 15	60 lbs. N prior to planting. 60 lbs. N after each cutting.
Lespedeza	Korean, Climax or Summit	20-25 lbs. seed in small grains	Feb. 15-Mar. 15	Test soil for lime, phosphate, and potash.
Grain Sorghum	DeKalb's C44B, E57, BR60, BR62; RS 610; Savannah	6 to 8 lbs. 38" to 40" rows	April 20-July 10	90 to 120 lbs. N prior to planting. For second crop add 60 lbs. after first harvest.
Oats	Coker 242, Ora, Moregrain, Delair, Midsouth	3 bu. for grazing 2½ bu. for grain	For grazing: early Sept. For grain: mid-Oct.	Grazing: 60 lbs. N at planting and 60 lbs. in Feb. Grain: 45 to 60 lbs. N Feb. 20-March 15.
Wheat	Ga. 1123, Knox, Bledsoe, Hadden, Atlas 66, Wakeland	1¼ bu. for grain 1½ bu. for grazing	Same as Oats	Same as for Oats.
Rye	Explorer, Elbon	1¼ bu. for grain 1½ bu. for grazing	Same as Oats	Same as for Oats.

Horticultural Crops

FRUIT

Apples (in order of ripening): Early Harvest, Lodi, Williams Early Red, Cauley, Golden Delicious, Red Delicious, Stayman Winesap.

Crab Apples: Transcendent, Dolgo, Yellow Siberian.

Strawberries: South Mississippi — Dabreak Headliner, Klonmore.

Elsewhere — Pocahontas, Dixieland, Blakemore.

Pears (in order of ripening): Ayres, Orient, Garber, Morgan, Waite, Kieffer.

Plums: Bruce, Burbank, Methley, Munson, America, Santa Rosa.

Peaches (in order of ripening): Central and North Mississippi—Dixired, Dixigem, Redhaven, Triogem, Halehaven, Loring, Sullivans Early Elberta, Georgia Belle, Elberta, Afterglow.

South Mississippi—June Gold, Hiland, Maygold, Keystone, Sunhigh, Southland, July Elberta, Redskin, Afterglow.

Pecans: Stuart, Desirable, Farley Lewis, Elliott.

North Mississippi (trial only)-Owens

Blackberries: Williams (semi-erect), Flint (semi-erect), Brazos (semi-erect), Thornless Boysen (trailing).

Raspberries: Sodus (purple), Sunrise (red), Morrison (black), Golden Queen (yellow).

Muscadines: **Black**—Magoon,* Burgaw,* Hunt, Creek, Thomas

Bronze—Dearing,* Wallace,* Topsail, Scuppernong, Higgins.

*At least one of these pollinator vines must be included with all plantings.

Bunch Grapes: Concord or Champanel (blue), Delaware or Catawba (red), Niagara (white).

FERTILIZERS FOR FRUIT CROPS

Recommendations are for annual applications on soil of average fertility where clean cultivation is practiced in the summer. Soil samples or leaf analyses in commercial orchards may indicate need for different ratios. Commonly in the Delta area, only nitrogen fertilizer is needed.

Tree Fruits	Grade	Pounds per tree
Applied under tree branches before growth begins in spring.		150-250
Apples, Pears	12-16-16	½
If trees blight seriously, nitrogen fertilizer can be reduced or omitted. Maximum rates should be reached at 15-20 years.		
Peaches, Plums	12-16-16	½
	33-0-0	¼
Apply two-thirds of N fertilizer before growth begins and one-third in June or July. Maximum rates should be reached at 6 to 10 years.		150-250 1-1½
Pecans	12-16-16	
Strawberries (Central and North Mississippi)		150-250
February	12-16-16	
June	12-16-16	100
September	12-16-16	
In South Mississippi apply 12-16-16 at rate of 3-5 pounds per 100 feet of row before setting plants and 1 to 3 pounds per 100 feet of row in January.		1-2 lbs. per vine
Blackberries, Dewberries, Raspberries		150-250
February	12-16-16	
June	12-16-16	
	33-0-0	150-250
Grapes (mature vines)	12-16-16	per year of age

VEGETABLE VARIETY AND FERTILIZER RECOMMENDATIONS

The variety and fertilizer information supplied here is based on tests throughout Mississippi. The varieties listed are suitable for both home garden and commercial purposes unless otherwise designated. Vegetables as a group require more fertilizer per acre than most other row crops. The Mississippi Soil Testing Service is recommended for problem soils, or for specific recommendations for individual farms. This is especially true where the soil reaction (pH) is not known since many vegetable crop failures are due to improper liming.

			Fertilizers pounds per acre		
CROP	VARIETY	pH	N	P_2O_5	K_2O
Asparagus	Mary Washington	6.0-7.0	50	100	100
			After cutting season topdress with		
			25	50	50
Beans and Peas		5.8-7.0	50	100	50
Bush Lima			Sidress in full bud stage with		
Small seeded	Clark's Bush, Dixie Butterpea, Henderson, Thaxter, Nemagreen**		32	0	0
Large seeded	Fordhook 242				
Colored seeded	Jackson Wonder				
Pole type lima	Carolina Sieva, Willow Leaf, Florida Speckle				
Bush snap	Contender (oval), Extender, Provider (round), Gallatin 50***, Corneli 14*** Slenderwhite				
Pole snap	Kentucky Wonder, Blue Lake				
English Pea	Thomas Lexton, Wando, Little Marvel				
Southern Pea	Mississippi Crowder, Mississippi Silver,** Bunch Purple Hull, Dixilee	5.8-7.0	20	40	0
Broccoli	Coastal, Primo, Spartan	5.5-6.5	20	40	40
			20-40 lbs. borax		
			When heads begin to form sidedress with		
			32	0	0
Cabbage	Round Dutch, Early Jersey Wakefield*				
Cauliflower	Snowball-E or Snowball-M				
Collard	Vates, Morris Heading				
Mustard	Florida Broadleaf, Giant Southern Curled	5.5-6.5	48	48	48
			Sidedress with		
			32	0	0
Radish	Cherry Belle, Scarlet Globe, White Icicle (long)				
Turnip	Purple Top White Globe, Just Right, Seven Top, Shogoin (greens)				

Beet	Detroit Dark Red	6.0-7.0	75	100	100
			Sidedress with		
Carrot	Gold Spike, Imperator, Chantenay		32	0	0
Spinach					
Savoy	Bloomsdale Long Standing, Old Dominion				
Smooth	Viroflay, Hybrid No. 7 or 10				
Cantaloupe	Rio Gold, Edisto, Hales Best No. 36, Homegarden*	5.5-6.5	40	80	80
			When plants begin to run sidedress with		
			30	30	30
Cucumber					
Slicing	Ashley, Long Green,				
Pickling	Model, Pixie				
Squash	Early Summer Crookneck, Early Prolific Straight neck, White Bush Scallop, Zucchini				
Watermelon	Blackstone, Verona, Charleston Gray, Garrisonian				
Eggplant	Florida Market, Black Beauty	5.5-6.0	75	100	100
			Sidedress with		
			32	0	0
Irish Potato	Red LaSoda, Superior, LaChipper				
Pepper, Bell	Early Calwonder, Keystone Resistant Giant				
Pepper, Hot	Long Red Cayenne	5.5-6.0	40	80	80
			Sidedress with		
Pepper, Pimiento	Trueheart Perfection, Mississippi Nemaheart**		30	30	30
Tomato					
Red	Marion, Floradel, Indian River, Manapal	6.0-7.0	60	120	60
			Sidedress with		
			40	40	40
Pink	Bradley				
Greenhouse Production	Tuckcross K** or O, Manapal, Mo. Hybrid 519 or 520		Based on soil testing		
Lettuce					
Leaf	Bibb, Salad Bowl	6.0-7.0	75	100	100
Head	Great Lakes (A36 or 118)				
			Sidedress with		
Greenhouse	Bibb, Grand Rapids		32	0	0
Okra	Emerald, Clemson Spineless, Louisiana Green Velvet	6.0-6.5	30	40	40
			Sidedress with		
			20	0	0
Onion	Granex, Grano, Multiplier*	6.0-7.0	50	100	100
			Sidedress with		
			50	0	0
Sweet Corn	Royal Gold, Golden Security, Illinichief Super Sweet, Seneca Brave	5.5-6.5	30	40	40
			Sidedress with		
			64	0	0
Sweet Potato	Centennial, Gold Rush, Unit I Porto Rico	5.5-6.5	40	80	80

*Home garden only. **For areas where nematodes are a problem. ***Processing.

FERTILIZER RECOMMENDATIONS FOR ORNAMENTALS

Soil tests are recommended; if they are not available, then use the following:

Plant	Applications Number	Applications Time	Fertilizer	Rate*
Shade Trees	1	Oct. to March	13-13-13	1 lb./in. trunk diameter, 3 ft. high
(Fertilize trees at least every three years. Distribute in holes 12 inches deep, spaced evenly within the branch spread and use at least 20 holes per inch of tree diameter.)				
Shrubs and Flowers	1	Spring	13-13-13	1 to 2 lbs./100 sq. ft.
(For lone or specimen shrubs, use ¼ to ½ lb. per plant.)				

For commercial greenhouse or nursery crops or for special plants, write for details.
*Equivalent amounts of N-P-K may be applied by other materials.

TUNG

Varieties: Isabel (L-2), Folsom (L-47), Gahl (L-51), La Crosse (F-99), and Lampton (F587).

Fertilization: Apply fertilizer to nonbearing orchards as shown in Table 1. Fertilize newly planted trees soon after growth starts, spreading the mixture evenly in bands about 6 inches wide, the inner edges of the bands about 12 inches from the tree trunks. In the second and subsequent years after planting, spread fertilizer evenly under the spread of the branches shortly before growth starts.

Fertilize bearing trees shortly before they blossom, adjusting rates to the potential yield as shown in Table 2. When annual leaf analyses indicate that the elements are critical or out of the optimum range, then specific recommendations can be made by personnel of the Experiment Station, or the U.S.D.A. Tung Laboratory.

Usually it is more economical to apply the nitrogen as anhydrous ammonia, aqua ammonia, or ammonium nitrate and the phosphorus and potassium as 0-10-30 or superphosphate and muriate of potash than to apply a complete mixed fertilizer. When a complete mixed fertilizer is used the ratio of elements should be 2-1-2; a 16-8-16 formula is manufactured for this purpose. If inadequate zinc is indicated by leaf analysis or symptoms, apply 2 ounces of commercial zinc sulphate per tree under 5 years of age. For older trees, apply 4 ounces. If magnesium or calcium is deficient, apply dolomitic lime to bring the pH up to 5.5 or 6.0. After the trees are large enough for the branches to nearly meet in the tree row, the fertilizer may be applied in bands on each side of the tree row. All solid fertilizers should be incorporated in the soil by cultivation.

Table 1. Fertilizer requirements of nonbearing tung orchards.

		Amount pounds/tree		
Years in the orchard	Fertilizer ratio	N	P_2O_5	K_2O
Newly planted	1-2-1	.05	.10	.05
One year	1-2-1	10	.20	.10
Two years	1-2-1	20	.40	.20
			pounds/acre	
Three years	2-1-2	50	25	50
Four years	2-1-2	60	30	60

Table 2. Fertilizer requirements of bearing tung orchards.

Potential production		pounds/acre	
tons/acre	N	P_2O_5	K_2O
0 to 1	75	25	75
1 to 2	100	50	100
2 or more	130	60	160